

NORTHEASTERN BULRUSH

(*Scirpus ancistrochaetus*)

RECOVERY PLAN



U.S. Fish and Wildlife Service, Region Five
Hadley, Massachusetts



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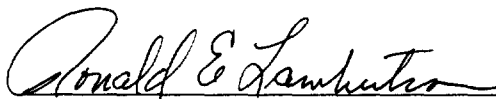
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Date:

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EXECUTIVE SUMMARY

Northeastern Bulrush Recovery Plan

Current Species Status: The northeastern bulrush (*Scirpus ancistrochaetus*) was listed as endangered on June 6, 1991. Thirty-three extant populations are currently known from seven eastern states; 11 historical populations are presumed extirpated. Several of the extant populations are small, and most are subject to threats ranging from habitat degradation or loss caused by development and land use practices, to natural threats such as succession and herbivory.

Habitat Requirements: *Scirpus ancistrochaetus* is found in ponds, wet depressions, or shallow sinkholes within small (generally less than one acre) wetland complexes. These wetlands are characterized by seasonally variable water levels.

Recovery Objective: To reclassify the northeastern bulrush from endangered to threatened status. A delisting objective will be based upon results of initial recovery tasks.

Recovery Criteria: Reclassification will be initiated when: 20 populations are permanently protected; annual monitoring over a 10-year period shows that 20 representative populations are stable or increasing; and life history and ecological requirements are understood sufficiently to allow for effective protection, monitoring, and management.

Recovery Strategy: The primary strategy for recovery of *Scirpus ancistrochaetus* involves restoring the species' rangewide distribution through protection of known extant populations and their habitat, as well as conducting searches for additional populations. In order to ensure long-term viability, investigations into ecological requirements of the species will be conducted, possibly leading to management of the species.

Actions needed:

1. Protect existing populations and their habitat through land protection, regulatory means, and education (Recovery Tasks 1 and 9).
2. Search for and protect additional populations (Task 2).
3. Monitor population trends and habitat conditions (Tasks 3 and 4).
4. Investigate the species' life history and reproductive strategy (Task 5).
5. Characterize the habitat and determine the environmental requirements of the species (Task 6).
6. Investigate the genetic variability and viability of the species (Task 7).
7. Secure, and store or propagate, genetic material from each genotype (Task 8).

Estimated Costs of Recovery (\$000):

<u>Year</u>	<u>Need 1</u>	<u>Need 2</u>	<u>Need 3</u>	<u>Need 4</u>	<u>Need 5</u>	<u>Need 6</u>	<u>Need 7</u>	<u>TOTAL</u>
FY1	33.0	16.5	21.5	8.0	1.0	2.5	1.0	83.5
FY2	46.0	13.5	13.5	13.5	7.5	7.5	1.0	102.5
FY3	38.0	13.5	14.0	17.5	7.0	9.0	1.0	100.0
FY4-10	<u>136.0</u>	<u>8.5</u>	<u>91.0</u>	<u>50.0</u>	<u>9.0</u>	<u>1.5</u>	<u>7.0</u>	<u>303.0</u>
TOTAL	253.0	52.0	140.0	89.0	24.5	20.5	10.0	589.0

Total Estimated Recovery Cost: Projected costs for reclassification amount to \$589,000.

Date of Recovery: Reclassification should be initiated in 2004, if recovery criteria have been met.

* * *

This recovery plan delineates reasonable actions needed to recover and/or protect the endangered northeastern bulrush (*Scirpus ancistrochaetus*). The plan does not necessarily represent the views of any individuals or agencies other than the U.S. Fish and Wildlife Service. It is subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks. Recovery objectives will be attained and funds expended contingent upon budgetary constraints affecting the parties involved, as well as the need to address other priorities.

Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1993. Northeastern Bulrush (*Scirpus ancistrochaetus*) Recovery Plan. Hadley, Massachusetts. 68 pp.

Additional copies of this plan can be purchased from:

Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814
301/492-6403
or 1-800/582-3421

Fees vary according to number of pages.

TABLE OF CONTENTS

PART I: INTRODUCTION	1
Description	2
Distribution and Status	7
Ecology and Life History	26
Threats to the Species	31
Conservation Measures	34
Recovery Strategy	36
PART II: RECOVERY	37
Recovery Goal	37
Recovery Objective	37
Recovery Tasks	38
References and Literature Cited	48
PART III: IMPLEMENTATION	50
APPENDIX: Current Laws and Regulations Protecting the Northeastern Bulrush	
LIST OF REVIEWERS	
Addendum: January 1994 report, Identification of Vegetative Plants	

LIST OF FIGURES AND TABLES

Figure 1.	<i>Scirpus ancistrochaetus</i> , (a) flowering/fruiting culm, (b) cluster of spikelets	3
Figure 2.	<i>Scirpus ancistrochaetus</i> achene (fruit) with six barbed bristles	4
Figure 3.	Morphological differences between <i>Scirpus ancistrochaetus</i> , <i>S. atrovirens</i> , and their hybrid	5
Figure 4.	The distribution of <i>Scirpus ancistrochaetus</i> in the northeastern United States	8
Table 1.	Summary of Habitat Types and Population Data for Extant Occurrences of <i>Scirpus ancistrochaetus</i>	9
Table 2.	Occurrence Records for Extant Populations of <i>Scirpus ancistrochaetus</i>	10
Table 3.	Habitat and Population Data for Extant Occurrences of <i>Scirpus ancistrochaetus</i>	13
Table 4.	Historical Occurrence Records of <i>Scirpus ancistrochaetus</i>	17

PART I: INTRODUCTION

The northeastern bulrush (*Scirpus ancistrochaetus* Schuyler) is a member of the sedge family (Cyperaceae) native to the northeastern United States. The species was listed as endangered under provisions of the Endangered Species Act of 1973, as amended, on June 6, 1991 (U.S. Fish and Wildlife Service 1991). Twenty of the 33 known extant populations occur on private land and are subject to habitat loss, modification, and degradation caused by residential and agricultural development.

Scirpus ancistrochaetus has been assigned a recovery priority number of 2C in a system ranging from a high of 1C to a low of 18 (Federal Register 48: 43103). This ranking is based on a high degree of threat exacerbated by imminent development pressures (indicated by the "C" designation), a high potential for achieving recovery, and the plant's taxonomic ranking as a species. Recovery priority numbers, which are assigned to all listed species, affect scheduling and funding of recovery activities.

This plan summarizes the information currently available on *Scirpus ancistrochaetus*, identifies threats that affect its survival and recovery, and specifies the steps that should be taken to achieve recovery objectives. The recovery program for this species is in its beginning phase, and the initial focus will be on taking those actions necessary to offset imminent threats to the species' survival and on acquiring the information needed to effectively direct future recovery activities.

DESCRIPTION

Scirpus ancistrochaetus, first described as a new species by A.E. Schuyler in 1962, is a leafy, perennial herb approximately 80-120 cm in height. The lowermost leaves are up to 8 mm wide and 40-60 times as long as wide, while the uppermost leaves are 3-5 mm wide and 30-50 times as long as wide (Schuyler 1962). Flowering culms (stems) are produced from short, woody, underground rhizomes.

The umbellate inflorescence has distinctly arching rays, which bear clusters of brown spikelets (small, elongated flower clusters) (Figure 1). Each of the minute flowers has six small (1.1-1.7 mm long), rigid perianth bristles, and each bristle is armed with thick-walled, sharply pointed barbs projecting downward. Flowers have 0-3 stamens and a 3-parted style. The yellow-brown achenes (Figure 2) are 1.10-1.35 mm long, obovate, and tough and thickened above the seed (Schuyler 1962). Flowering occurs from mid-June to July, and fruit sets between July and September (Crow 1982).

TAXONOMY

The northeastern bulrush is one of 18 members (in North America) of a natural group of "leafy bulrushes" within the genus *Scirpus*. Species in this group are "characterized by having tough fibrous rhizomes, 3-angled culms with well developed leaves, and terminal much-branched inflorescences subtended by leaf-like involucre bracts" (Schuyler 1967: 295). Each flower is subtended by a scale, and the flowers are spirally arranged in spikelets. The spikelets are either solitary at the tips of pedicels or occur in clusters at the tips of the inflorescence rays (Schuyler 1967). The fruits (achenes) are usually <1.5 mm long, contain a single seed, and usually have the bristles fused at their bases. Schuyler (1967) describes additional characteristics of the group, and provides a complete key to the North American leafy species of *Scirpus*.

Not all botanists consider *S. ancistrochaetus* to be a distinct species, e.g., Gleason and Cronquist (1991) do not categorize the plant as a separate species in their authoritative guide to the vascular plants of the northeastern United States. However, based on the morphological and genetic evidence, as well as the botanical expertise of A.E. Schuyler with the genus *Scirpus*, the U.S. Fish and Wildlife Service recognizes *S. ancistrochaetus* as a species.

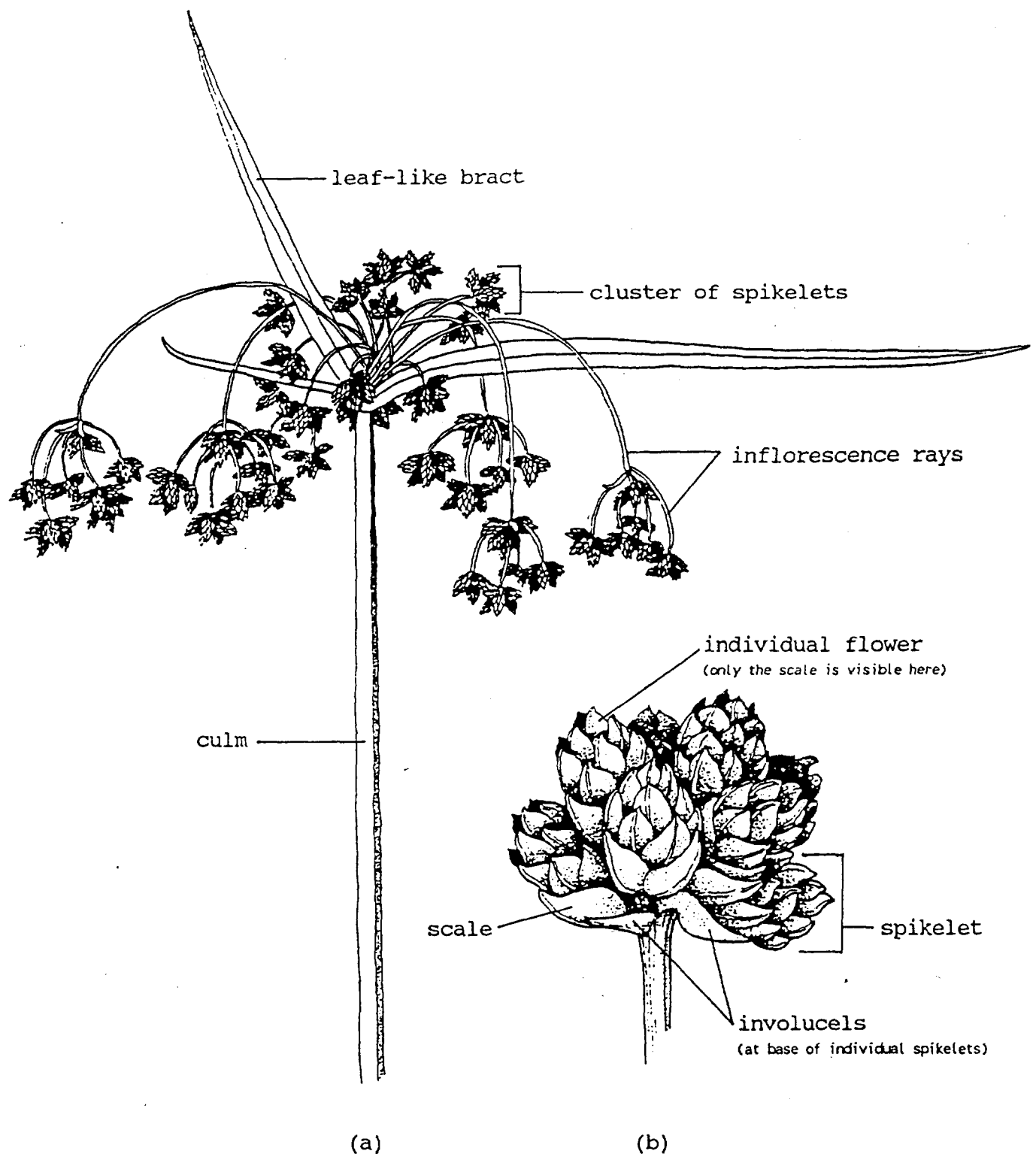
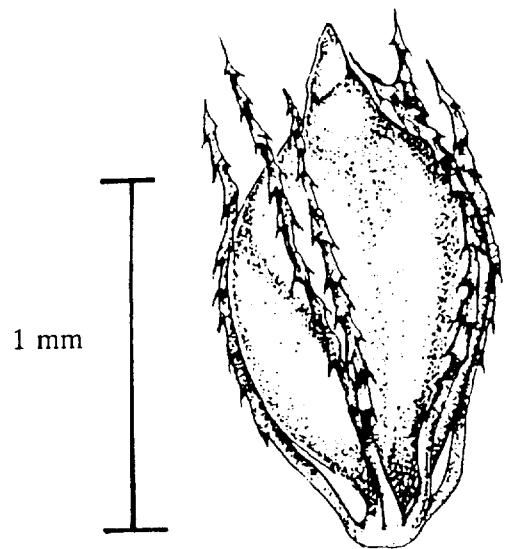


Figure 1. *Scirpus ancistrochaetus*, (a) flowering/fruiting culm, (b) cluster of spikelets.
Illustration by Gayle Bisbee.

Figure 2. *Scirpus ancistrochaetus*
achene (fruit) with six
barbed bristles.
Illustration by Cherie Taylor.



Scirpus ancistrochaetus is morphologically similar to *S. atrovirens*, *S. hattorianus*, and *S. georgianus*, but can be readily distinguished from them by the strongly arching rays of its inflorescence and the rigid, retrorse (turned backward or downward) barbs on its six perianth bristles. In contrast to *S. ancistrochaetus*, *S. atrovirens* has less ascending inflorescence rays, smaller achenes, and flowers with 4-6 delicate, wrinkled bristles covered with round-tipped, retrorse teeth (Schuyler 1962, 1963). Figure 3 illustrates some of the morphological differences between *S. ancistrochaetus* and *S. atrovirens*, and also illustrates the intermediate morphological characteristics of their hybrid. *Scirpus georgianus* is readily distinguishable from *S. ancistrochaetus*, because it lacks bristles, or has, at most, up to three short bristles (Schuyler 1967).

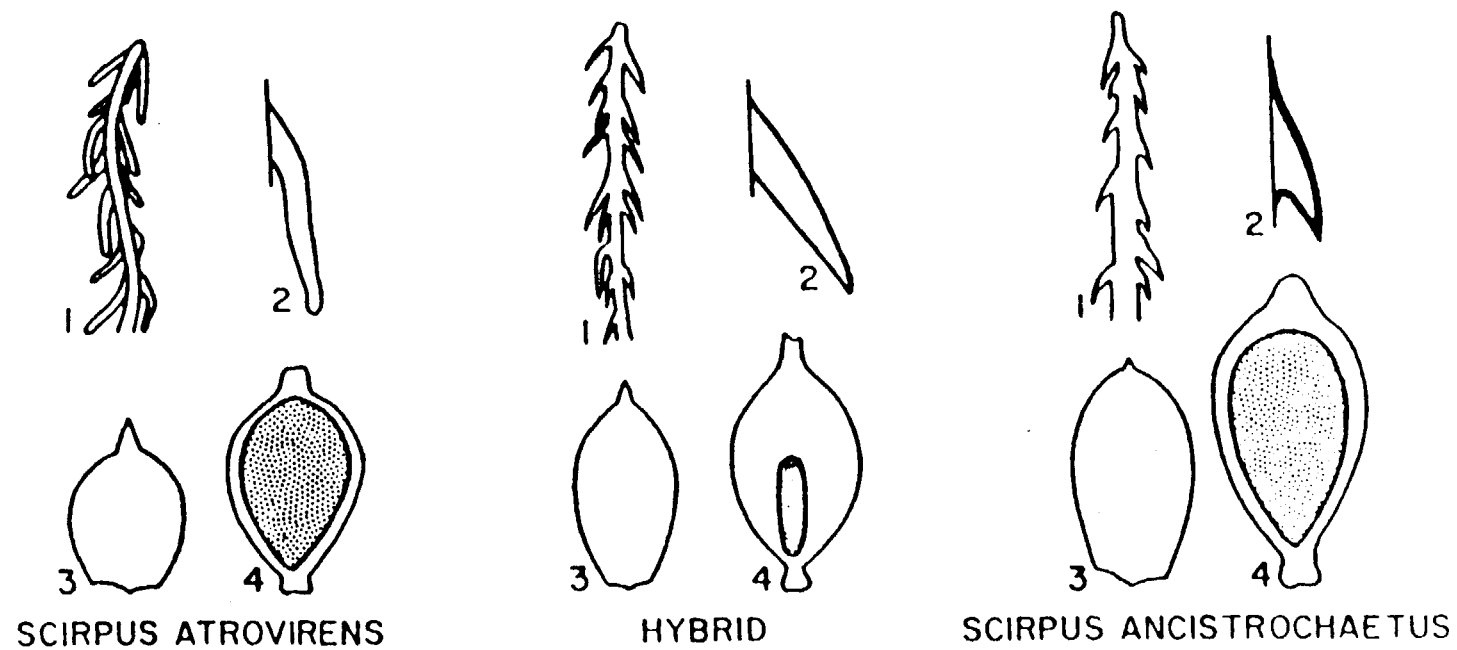


Figure 3. Morphological differences between *Scirpus ancistrochaetus*, *S. atrovirens*, and their hybrid. 1 - Bristle tips, 2 - Bristle teeth, 3 - Scales, 4 - Fruits with inclosed seeds (stippled). Taken from Schuyler 1962, Figure 1.

GENETIC RELATIONSHIPS

Chromosome number varies from 14-34 in this group, but appears to be consistent for each species. Schuyler (1967) asserted that species with low numbers of chromosomes are morphologically primitive and that species with high chromosome numbers may have been derived from species with lower numbers through hybridization. Chromosome number also seems to be correlated with the amount and complexity of interspecific hybridization, i.e., hybrids are more prevalent among species with higher numbers of chromosomes (Schuyler 1967).

S. ancistrochaetus, which has 27 meiotic units, is known to hybridize with *S. atrovirens* (28 meiotic units) (Schuyler 1975). These two species are morphologically very similar. In a detailed study of *S. atrovirens*, *S. ancistrochaetus*, and hybrid (*S. atrovirens* X *ancistrochaetus*) specimens, Schuyler (1963) found considerable morphological variation within the two taxa, and hybrids that were intermediate, both in vegetative and reproductive characteristics, between the two parents. All hybrids studied, however, were highly sterile, having abortive pollen grains and seeds.

S. ancistrochaetus also hybridizes with *S. hattorianus* (28 meiotic units), producing a sterile, morphologically intermediate hybrid. At the type locality for *S. ancistrochaetus*, Schuyler (1967) found *S. atrovirens* and *S. hattorianus*, as well as *S. atrovirens* X *ancistrochaetus* and *S. hattorianus* X *ancistrochaetus*. Both hybrids were highly sterile. He also found a group of plants that were morphologically intermediate between *S. hattorianus* X *ancistrochaetus* and *S. hattorianus*. Some of these plants were fertile (having well-developed seeds), and, interestingly, they resembled the type specimen of *S. atrovirens*, suggesting to Schuyler that *S. atrovirens* may have originated as a backcross between *S. hattorianus* and *S. hattorianus* X *ancistrochaetus*. This may explain why *S. atrovirens* is morphologically intermediate between *S. ancistrochaetus* and *S. hattorianus* (Schuyler 1967).

The implication of these investigations is expressed in the following statement: "The ancestral relationship of *Scirpus ancistrochaetus* to *S. atrovirens*, as well as its scarcity and scattered occurrence in isolated wetlands in areas where the flora has been well researched, suggests that *S. ancistrochaetus* is a relict species (A.E. Schuyler, Academy of Natural Sciences of Philadelphia, pers. comm., 1990)" (U.S. Fish and Wildlife Service 1990).

DISTRIBUTION AND STATUS

Extant populations of *S. ancistrochaetus* are currently known from Maryland (1 population), Massachusetts (1), New Hampshire (1), Pennsylvania (22), Vermont (2), Virginia (4), and West Virginia (2) (Figure 4). Twelve of these 33 populations occur on state lands, one occurs partially on state land and partially on private land, and 20 occur on private lands. Populations on private land face the most immediate threats, primarily habitat loss and degradation caused by wetland draining, dredging, and filling for residential and agricultural development. Table 1 summarizes habitat types and population data by state. General locational information and a summary of threats to each population are presented in Table 2. Table 3 contains population data and habitat descriptions for each occurrence.

Historical collections of *S. ancistrochaetus* have been documented from Pennsylvania and New York, and possibly Virginia, but to date no historical collections have been confirmed from the other states within the species' range. Historical occurrence records are summarized in Table 4. A description of current and historical population status by state follows.

MARYLAND

Maryland's single population is located on private property in Washington County, within the acquisition boundary of a State Wildlife Management Area (Bartgis 1989). The population consists of a 7.1 m x 5.3 m stand in the corner of a small (0.2 acre), shallow sinkhole pond on a low, flat sandstone ridge in the Ridge and Valley province. Water levels in this pond vary both seasonally and annually (Bartgis 1992b). In a 1991 census, 136 well-defined clumps were identified, with an average of three flowering stems/clump and 4.3 non-flowering stems/clump (Bartgis 1992a). The plant is absent from two other associated ponds (Bartgis 1992b). Possible threats to this population include residential development and succession (invasion of woody plants). No historical records are known from the State.

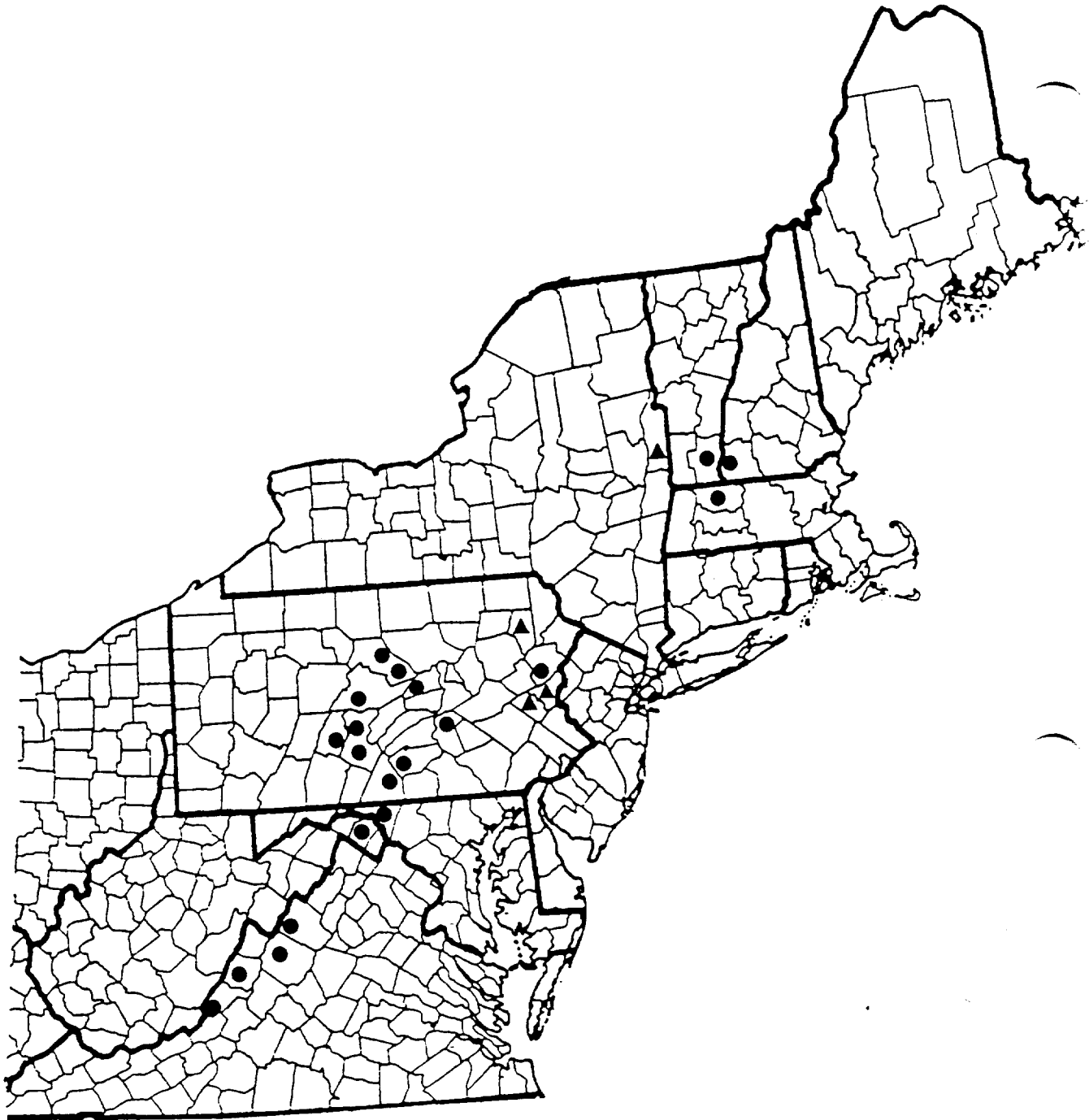


Figure 4. The distribution of *Scirpus ancistrochaetus* in the northeastern United States. Counties with extant (●) versus historic only (▲) occurrences.

TABLE 1. SUMMARY OF HABITAT TYPES AND POPULATION DATA FOR EXTANT OCCURRENCES OF *SCIRPUS ANCISTROCHAETUS*

STATE	NUMBER OF EOs ¹	REPRESENTATIVE WETLAND/POND TYPE(S)	ESTIMATED ² POPULATION SIZE ³	DATE OBS.
MARYLAND	1	sinkhole	136 clumps (408)	1991
MASSACHUSETTS	1	wet depression in sandplain	4 plants (23)	1989
NEW HAMPSHIRE	1	breached beaver pond	15 clumps [60]	1992
PENNSYLVANIA	22	forested wetlands, woodland ponds, vernal pools, emergent wetlands, ombrotrophic marsh/shrub swamps	> 63 clumps (>4600) [>26,000]	1992
VERMONT	2	alluvial meadow, beaver pond	8 clumps (27)	1992
VIRGINIA	4	sinkholes, mountain ponds	>240 clumps (>70)	1987, 1989
WEST VIRGINIA	2	sinkholes	2000-6000 clumps (6700-25,000) [66,000-84,000]	1991
TOTAL	33	--	2500-6500 clumps (11,800-30,100) [92,000-110,000]	1991, 1992

¹ EOs = element occurrences (occurrences of the species as determined by the respective state heritage programs).

² Note that for Pennsylvania, population estimates are extremely conservative because not all population parameters (i.e., number of plants/clumps, number of flowering/fruitle culms, total number of culms) were reported for each occurrence.

³ Generally the number of mature plants or clumps with flowering or fruiting culms.

() = the number of flowering/fruitle culms: [] = total number of culms (vegetative and flowering/fruitle).

Clump = physical aggregation of 1 or more plants

Culm = stem; may refer to flowering/fruitle stems and/or total number of stems (see above).

Plant = not well defined; sometimes equivalent to a clump

Source of information in table: Natural Heritage Program status reports and data files from the respective state heritage programs. (Bartgis 1989, 1992; MA NHP 1990; PNDI 1991, 1992, 1993; Rawinski 1989, 1990; Thompson 1990, 1991)

TABLE 2. OCCURRENCE RECORDS FOR EXTANT POPULATIONS OF *SCIRPUS ANCISTROCHAETUS*

STATE	EO NO ¹	COUNTY	USGS QUADRANGLE	SITE LOC. ²	THREATS TO POPULATION
MD	001	Washington	Cherry Run	P	Invasion of woody plants.
MA	001	Franklin	Greenfield	P	Succession; possible development.
NH	001	Cheshire	Bellows Falls	P	Timbering; skid roads near site. Beaver dam broken (bulldozed) in making logging roads.
PA	001	Clinton	Loganton	SF	Agricultural runoff; flooding by beaver.
	003	Huntingdon	Butler Knob	SGL/P	Timbering.
	004	Huntingdon	Alexandria	P	Powerline maintenance; jeep road bisects one of the wetlands harboring the occurrence; trampling, browsing by deer.
	005	Clinton	Loganton	SF	Timbering.
	006	Clinton	Glen Union	P	Area surrounding occurrence has been logged (high-graded); additional land is designated for timber removal. Threats: continued clearing/cutting, use of heavy equipment near occurrence.
	007	Clinton	Glen Union	SF	Timbering.
	008	Clinton	Loganton	SF	Timbering. Trash present in wetland. Camp with lawn and large cleared area within immediate watershed harboring occurrence.
	009	Clinton	Loganton	SF	Timbering. Road near site--road maintenance (drainage ditches) may alter drainage patterns and affect hydrology of site.
	010	Centre	Julian	SGL	Timbering.
	011	Blair	Williamsburg	P	Occurrence close to paved road (threat: road widening, salt runoff). Other threats: agricultural runoff, residential development, clay pit expansion.
	509	Monroe	Brodheads ville	P	Residential and industrial water drawdown; herbicide and fertilizer runoff; commercial zoning of lands bordering lake.
	510	Dauphin	Lykens	SGL	Browsing by deer (plants eaten to ground in 1991).

Table 2 (continued)

STATE	EO NO ¹	COUNTY	USGS QUADRANGLE	SITE LOC. ²	THREATS TO POPULATION
PA	511	Franklin	Scotland	SF	Surrounding woods recently clearcut, narrow border left around pond; much scraping of soil surface evident. Intrusion of exotics. Browsing and trampling by deer. Abandoned rail road bed close to pond.
	512	Franklin	Scotland	P	Jeep lanes and past bulldozing along edge of 1 pond; second pond partially filled. Selective cutting recently done. Residential development nearby may alter water table and increase nutrient levels in ponds.
	513	Cumberland	Walnut Bottom	SF	Surrounding woods clearcut near pond; may cause erosion problems (sedimentation). Ore pit and old excavations adjacent to pond. Intrusion of exotics (weeds) evident on edge of pond. Trampling and browsing by deer evident.
	514	Cumberland	Dickinson	P	Residential development (house near edge of pond). Fill material blocking natural outlet of pond. Timbering. Trash dumping evident in other ponds nearby.
	515	Union/Lycoming	Carroll	SF	Evidence of deer browsing.
	516	Union	Hartleton/Carroll	SF	Logging on 2 sides of pond; pond receiving runoff from adjacent dirt road.
	517	Dauphin	Enders	SGL	ATV ruts at edge of pond. Wood duck boxes in pond. Deer browsing evident. Food plots and logging near pond.
	518	Franklin	Scotland	P	All ponds surrounded by nearly clearcut forest (peripheral swamp forest zones of wetlands also cut); 2 ponds with plants have abundant stumps, slash, and snags within them (threat: nutrient enrichment due to added plant material). Intrusion by exotics. Residential development nearby.
	519	Cumberland	Walnut Bottom	P	Residential development nearby; immediate area around occurrence being surveyed for development. Surrounding woods selectively cut; lots of native and exotic weedy species in woods. Evidence of jeep roads and garbage dumping in area.
	520	Union	Hartleton	P	Timbering; slash piles in pond--threat of intrusion by exotics. Also potential for filling, draining of pond; agricultural runoff.
VT	001	Windham	Bellows Falls	P	Agricultural runoff.
	002		Saxtons River	P	Succession, if not periodically inundated by beaver activity.

Table 2 (continued)

STATE	EO NO ¹	COUNTY	USGS QUADRANGLE	SITE LOC. ²	THREATS TO POPULATION
VA	002	Rockingham	Grottoes	P	Damage from off road vehicles.
	003	Bath	Mountain Grove	P	Small portion of pond has been excavated.
	004	Allegheny/Craig	Potts Creek	P	ATVs. Pond on inholding within National Forest.
	005/ 006	Augusta	Crimora	P	Residential development; ditching and dredging. In wetland complex, 1 pond destroyed by housing development, and 1 pond deepened by bulldozer.
WV	001	Berkeley	Big Pool	P	ATV damage during droughts. Ponds on tract subdivided for estate settlement. Intensive real estate development in immediate area.
	002			P	Invasion of woody plants; residential development. Attempt made in past to drain one pond with a ditch.

¹ Element occurrence number (assigned by corresponding state natural heritage program)

² Site location: P = Private land; SF = State Forest; SGL = State Game Lands

Source of information in table: Natural Heritage Program status reports and data files from the respective state heritage programs. (Bartgis 1989, 1992; MA NHP 1990; Pennsylvania Natural Diversity Inventory 1991, 1992, 1993; Rawinski 1989, 1990; Thompson 1990, 1991)

TABLE 3. HABITAT AND POPULATION DATA FOR EXTANT OCCURRENCES OF *SCIRPUS ANCISTROCHAETUS*

STATE	EO NO ¹	POND TYPE	POPULATION SIZE ²	DATE OBS.	DATE FIRST OBS.	DESCRIPTION OF OCCURRENCE ³
MD	001	sinkhole	136 clumps (408)	1991	1989	7x5 m patch of plants in corner of small pond; absent from 2 nearby ponds.
MA	001	wet depression in sandplain	4 plants (23)	1989	1928	Plants occur on small island in center of pond; plants absent from 2 nearby ponds. No plants observed in 1978, 1982
NH	001 ?	breached beaver pond	15 clumps [60]	1992	1992	Plants growing in exposed mud bank of recently drained beaver pond; stream channel now cuts through wetland. Second beaver dam (and pond) occurs upstream of broken dam. Pond surrounded by transitional hardwood-pine-hemlock forest. SR & ASR.
PA	001	bog/marsh	2 clumps (27) 2 clumps (15)	1985 1991	1940	Plants occur on edge of marsh/forest interface. Water level raised by beaver. No plants observed in 1983, 1987 or 1989.
	003	forested wetland	(80) [380]	1992	1992	Much of wetland consists of ferns growing on sphagnum hummocks. Plants in wettest portion of wetland. SR.
		marsh	[10,400]			Plants occur within the 3 wetland openings of the marsh, surrounded by swamp forest, surrounded by mixed oak forest. Stand sizes: 12m ² , 50m ² & 1500m ² , with 100, 300 & 10,000 culms. SR.
		emergent wetland	[200]			Single pond with two 6x6m stands (100 + 100 culms) at opposite ends. Surrounded by mixed oak forest. No information available on reproduction.
	004	ombrotrophic marsh	[1450]	1992	1992	Plants occur in wetland in a powerline clearing; wetland bisected by jeep road. Site 0.3 miles from the rest of the occurrence (see below). Stand sizes: 1500m ² & 100m ² , with 1000 & 450 culms. SR.
		ombrotrophic marsh	[430]			Plants occur in 3 of 5 wetlands surrounded by swamp forest. Stand sizes: 40m ² , 1m ² & 15m ² , with 300, 30 & 100 culms. SR.
	005	NA	NA	1992	1992	NA
	006	woodland pool	[50-100] ⁵	1992	1992	Plants occur in center of small (<5m across) pool, surrounded by recently timbered forest. Prolific ASR.
	007	woodland pool	[100-1000] ⁵	1992	1992	Plants occur in 3x5m stand in center of 10x12m pool surrounded by mixed oak forest. Plants may also occur in another nearby pond. SR & ASR.

Table 3 (continued)

	EO NO ¹	POND TYPE	POPULATION SIZE ²	DATE OBS.	DATE FIRST OBS.	DESCRIPTION OF OCCURRENCE ³
PA	008	woodland pool	[11-50] ⁵	1992	1992	Plants occur in 1 of 3 permanent pools within forested wetland complex. Pool size 5x5m.
	009	emergent wetland/marsh	[100-1000] ⁵	1992	1992	Plants in wettest part of 10x15m wetland, surrounded by mixed oak forest. SR.
	010	ombrotrophic basin marsh	1 clump (17) [34]	1992	1992	Plants occur in 1 of 15 wetlands examined. Wetland with occurrence is a marsh/shrub swamp, surrounded by narrow zone of swamp forest, surrounded by mixed oak forest. SR & ASR.
	011	ombrotrophic basin wetlands	10 clumps [100]	1992	1992	Plants occur in 1 of 14 wetlands in complex. Stand size: 50m ² . Plants occur in marsh/shrub wetland, surrounded by narrow zone of swamp forest, surrounded by mixed oak forest. ASR.
	509	kettle lake	23 plants (143)	1990	1990	Plants occur at edge of shallow lake. Extensive ASR.
STATE	510	vernal pool	15 plants (50) [250]	1992	1991	Plants occur in 1 of 5 partially shaded ponds within wetland complex surrounded by oak-heath forest. SR & ASR.
	511	ombrotrophic basin marsh	(60) [300]	1992	1988	Plants occur in 1 isolated pond surrounded by recently clearcut forest. SR.
	512	ombrotrophic basin marsh	(2000) [4000] + 1 clump (2) [8]	1992	1985	Plants occur in 2 of a complex of 5 vernal ponds surrounded by oak-heath woods. SR & ASR.
	513	ombrotrophic basin marsh	[2600]	1992	1990	Plants occur in small vernal pond surrounded by shrub swamp or forest. SR.
	514	woodland pond	(150) [650]	1992	1992	Pond surrounded by oak-heath forest. SR & ASR.
	515	woodland pond	(500-700)	1992	1992	Plants occur in 3 ponds (300-500 + 75 + 150-200 flowering culms). Ponds occur in a cluster of 28 vernal ponds (many need to be searched yet) in a mixed oak forest.
	516	woodland pond	(200) [hundreds]	1992	1992	Plants in nearly full sun in 0.25 acre pond at the headwaters of a run. SR & ASR.
	517	woodland pond	(>1000) [thousands]	1992	1992	Plants in open area (exposed to full sun) in 0.75 acre pond. SR & ASR.

Table 3 (continued)

	EO NO ¹	POND TYPE	POPULATION SIZE ²	DATE OBS.	DATE FIRST OBS.	DESCRIPTION OF OCCURRENCE ³
PA	518	ombrotrophic basin marsh	10 clumps (45) [135]	1992	1992	Plants occur in 4 ponds (roughly equal populations in each pond) of complex of 34 ombrotrophic basin ponds. Prior to clearcut, ponds were surrounded by shrub swamp forest, surrounded by mixed oak forest. SR & ASR.
	519	woodland pond	(250) [1250]	1992	1992	Plants occur in isolated 0.75 acre pond. SR & ASR.
	520	woodland pond	1 plant [<10]	1992	1992	Plants occur in 1 of a cluster of small ponds (vernal pools) surrounded by recently timbered forest. SR & ASR.
VT	001	alluvial meadow	(1) 69 plants 11 plants 10 plants 1 clump (7)	1979 1985 1987 1989 1992	1960	Plants occur in 2 of 3 ponds. Pond water level increased due to beaver activity. No plants seen in 1990, 1991. Type locality.
STATE	002	beaver ponds (meadows)	12 plants 8 plants 3 plants (6) 7 clumps (20)	1985 1990 1991 1992	1915	Plants occur in 3 of 4 ponds. No plants seen in 1989. Additional plants found in new location at site in 1992.
VA	002	sinkhole	100+ plants	1987	1969	Plants occur in 2 adjacent ponds in wetland complex. Only SR.
	003	mountain pond	thousands of plants	1985	1985	Vigorous population occurs in 1 isolated pond.
	004	mountain pond	NA	1987	1985	Plants occur in 1 isolated, 1-acre pond.
	005/ 006	sinkhole	140 clumps (70)	1989	1989	Population of 130 and 10 clumps occurs in 2 ponds (0.2 miles apart); plants absent from 6 other ponds in wetland complex.
WV	001	sinkhole	2000-6000 clumps (6700-25,000) [65,000-83,000]	1991	1988	Population consists of 3 discrete stands within 2 ponds; absent from 3 nearby ponds.
	002	sinkhole	[>1000]	1989	1989	Population occurs as 3 discrete patches within 1 pond, and 1 stand in another pond.

Table 3 (continued)

¹ Element occurrence number (assigned by corresponding state natural heritage program).

² Generally the number of mature plants or clumps with flowering or fruiting culms
() = the number of flowering/fruiting culms. [] = total number of culms (vegetative and flowering/fruiting).

Clump = physical aggregation of 1 or more plants.

Culm = stem; may refer to flowering/fruiting stems and/or total number of stems (see above).

Plant = not well defined; sometimes equivalent to a clump.

³ "Plants" refers to plants of *Scirpus ancistrochaetus*.

"Stand size" refers to size of the *Scirpus ancistrochaetus* stand.

SR = sexual reproduction evident.

ASR = asexual reproduction evident.

⁴ Only a range was given for the population size.

Source of information in table: Natural Heritage Program status reports and data files from the respective state heritage programs.
(Bartgis 1989, 1992; MA NHP 1990; PNDI 1991, 1992, 1993; Rawinski 1989, 1990; Thompson 1990, 1991).

TABLE 4. HISTORICAL OCCURRENCE RECORDS OF *SCIRPUS ANCISTROCHAETUS*

STATE	COUNTY	QUAD ¹	EO NO ²	DATE LAST OBS.	STATUS/NOTES
NY	Washington	Putnam Mountain	?	1900	Locational references obscure. Surveyed in 1989.
PA	Blair	Tyrone	002	1865	Locational references obscure. Surveyed in late 1970s.
	Lackawanna	Avoca	503	1985	1 plant found in 1985. Mountaintop bald burned in 1988. No plants observed 1986-1991.
		Dalton	501	1946	Surveyed in 1963, 1986. Habitat still present. Resurvey.
		Carbondale	502	1897	Locational references obscure. Owned by Lackawanna Co. Dept. Parks & Recreation. Surveyed in 1986. Resurvey.
	Lehigh	Slatedale	504	1915	Locational references obscure. Surveyed in 1963, 1985, 1987. Site destroyed by slate quarry and farming.
		Allentown West	505	1921	Locational references obscure. Surveyed in 1963, 1977, 1989. Habitat of historical record destroyed (filled). Survey vernal pools in surrounding area. Owned by PP&L.
		unmappable	506	1926	Locational references obscure.
	Northampton	Kunkletown	507	1940	Locational references obscure. Surveyed in 1976. Original occurrence and its habitat possibly destroyed (diked).
VA	Monroe	Mount Pocono	508	1936	TNC preserve. Surveyed in 1985. Habitat no longer suitable due to encroachment of woody vegetation.
	Rockingham	Brandywine	001	1970	Located on George Washington National Forest. Last surveyed in 1984; population not located, but entire area will be protected within "Special Interest Area" on the NF. Resurvey.

¹ USGS 7.5-minute quadrangle map

² Element occurrence number (assigned by corresponding state natural heritage program)

Source of information in table: Natural Heritage Program status reports and data files from the respective state heritage programs. (Bartgis 1989, 1992; MA NHP 1990; PNDI 1991; Rawinski 1989, 1990; Thompson 1990, 1991)

MASSACHUSETTS

The Massachusetts population is located in Franklin County, on land owned by a utility company. The population consists of four plants growing on an islet in the middle of a shallow, bowl-shaped depression in a sand plain in the Connecticut River Valley (Massachusetts Natural Heritage Program 1990). Water levels in the pond fluctuate with the water table, from high in wet years to low in drought years. Plants have persisted at this location since at least 1928, but they may be jeopardized by the invasion of woody plants. The 1928 specimen from this site was recently annotated to *S. ancistrochaetus*. No historical records are known from the State.

NEW HAMPSHIRE

In 1992, three river shore wetland complexes and 21 hillside wetlands in New Hampshire were surveyed for the presence of the northeastern bulrush. One hillside wetland, described as a drained beaver flowage, was found to support a small population (15 clumps) of *S. ancistrochaetus*. The habitat is a grass/sedge dominated mud bank -- the bank was apparently exposed when bulldozers, in the process of developing logging roads, destroyed the beaver dam, causing the pond to drain. The drained pond contains a 5-12 foot wide stream channel. The northeastern bulrush was found in the slightly higher, recently exposed mud banks, along with *Scirpus cyperinus* and *Dulichium arundinaceum*. This site is on private property and is threatened by logging and wetland alterations.

NEW YORK

Obscure locational references have made it difficult to locate the sole historical occurrence in New York. A single specimen was collected in 1900 at "Mt. Nebo," a site researchers have been unable to locate on any maps of New York (Mitchell and Sheviak 1981).

PENNSYLVANIA

Extant Occurrences

Pennsylvania has 22 extant occurrences of *S. ancistrochaetus*. Nine of these occurrences are on State Forest land (under the jurisdiction of the Department of Environmental Resources, Bureau of Forestry), three are on State Game Lands (under the

jurisdiction of the Pennsylvania Game Commission, Bureau of Land Management), one spans State Game Lands and privately owned land, and nine are on privately owned land.

All but two of the Pennsylvania occurrences are found in the Ridge and Valley, and South Mountain physiographic provinces. All sites are "situated in hilly or mountainous areas, such as ridgetops, upper slopes near the headwaters of streams, and gentle lower slopes at the base of mountains" (J. Kunsman, The Nature Conservancy, pers. comm.). Site elevations range from 500 to 1900 feet. The northeastern bulrush has not been found in floodplain or bottomland ponds that exhibit water level fluctuations, nor in artificial habitats (ditches, borrow pits) (J. Kunsman pers. comm.). Below is a summary of the Pennsylvania sites. For more detailed, site-specific information, refer to Tables 2 and 3.

Occurrences on State Forest Land

The nine occurrences on State Forest land are in Clinton, Franklin, Cumberland, Union and Lycoming counties. The primary threat to these populations is potential adverse impacts from timber harvesting. Most of the Clinton County occurrences (EO 005, 007, 008, and 009) are found in woodland pools or small forested wetlands surrounded by mixed oak forest. These populations are moderate in size. The other Clinton County occurrence (EO 001) consists of only two plants growing on the edge of a marsh/forest interface. This site is protected within a State Forest Natural Area, but beaver activity in the area has greatly increased the water level in the marsh and may jeopardize the continued existence of this small population. EO 001 is the only northeastern bulrush occurrence in Pennsylvania adversely affected by beaver activity.

In February 1992, A.E. Schuyler verified that specimens collected from vernal pools in south-central Pennsylvania, were, in fact, *S. ancistrochaetus*. Two of these populations occur on State Forest land in Franklin (EO 511) and Cumberland (EO 513) counties in the South Mountain physiographic province of Pennsylvania. The populations are moderate in size, and occur in single, isolated ombrotrophic basin marshes. The forest around both occurrences has been recently clearcut, close to the edge of the ponds. This may result in a significant increase in the water levels of the ponds and in the amount of siltation.

The two occurrences in Union and Lycoming counties are also found in woodland ponds surrounded by mixed oak forest. EO 515 is a fairly large

population (500-700 flowering/fruiting culms) occurring in three ponds of a 28-pond complex. EO 516 is also fairly large (hundreds of vegetative culms), but occurs in a small (0.25 acre) isolated pond at the headwaters of a run. The forest on two sides of this pond has been logged, and the pond is receiving runoff from an adjacent dirt road.

Occurrences on State Game Land

The three occurrences on State Game Lands are located in Centre, Dauphin, and Huntingdon counties. The primary threats to these populations are from timbering operations and possibly deer browsing. The Centre County occurrence (EO 010) is very small (one clump) and exists in a woodland pond surrounded by a marsh/shrub swamp, which is surrounded by a narrow zone of swamp forest. This small wetland complex is surrounded by mixed oak forest, as is typical of several other Pennsylvania occurrences. In this immediate area, 15 wetlands were examined for the presence of northeastern bulrush, but the species was only found in one pond.

A population of approximately 15 plants (EO 510) occurs in one pond of a small, partially shaded complex of five vernal pools surrounded by oak-heath forest in Dauphin County (Pennsylvania Natural Diversity Inventory 1991). The other Dauphin County occurrence (EO 517) consists of a very large population (thousands of culms) in an unshaded 0.75-acre woodland pond. This population may be threatened by all-terrain vehicles (ATV ruts were evident at the edge of the pond) and management practices near the pond (adjacent food plots and logging).

Occurrences on State Land/Private Land

One of the Huntingdon County occurrences (EO 003) occurs on both State Game Lands and on private land. The largest portion of this population (over 10,000 culms) is on State Game Lands and occurs as three stands within three wetland openings of a marsh surrounded by swamp forest. The swamp forest is surrounded by mixed oak forest. Approximately 0.25 mile to the south of this wetland, and also on State Game Lands, lies another wetland (single pond) which supports two stands of *S. ancistrochaetus*. This wetland is also surrounded by mixed oak forest. The remainder of this occurrence lies approximately 0.75 mile to the north of the marsh (which supported over 10,000 culms) in a small wetland on

private land. Most of this area consists of ferns growing on sphagnum hummocks; the bulrush occurs in the wettest portion of this wetland.

Occurrences on Private Land

The nine occurrences on private land are located in Blair, Clinton, Cumberland, Franklin, Huntingdon, Monroe, and Union counties. The relatively small Blair County population (about 100 culms) (EO 011) occurs in one of 14 ponds in a marsh/shrub wetland complex surrounded by swamp forest. This complex is surrounded by mixed oak forest. Because this population is close to a paved road, it may be threatened by residential development, road widening, and/or runoff (salt and other chemicals) from the road.

The Clinton County population (EO 006) occurs in the center of a small (less than 5 m across) pool. The area surrounding the pool has been logged (high-graded), and additional land is designated for timber removal. This population is threatened by the effects of past and continuing logging operations.

Both Cumberland County occurrences (EO 514 and 519) occur in solitary woodland ponds, and are relatively large populations (650 and 1250 culms, respectively). Both populations are threatened by residential development. At EO 514, there is a house near the edge of the pond supporting the northeastern bulrush population, and trash has been dumped in other ponds nearby. This population may also be threatened by timbering operations and the presence of fill material blocking the natural outlet of the pond. The immediate area surrounding EO 519 is being surveyed for development, and the surrounding woods have been selectively cut, encouraging the growth of native and exotic weedy species in the woods. There is also evidence of jeep roads and garbage dumping in the immediate area.

A large Franklin County population (about 4000 culms) (EO 512) occurs in two of a small complex of woodland ponds surrounded by oak-heath woods. One of these ponds was partially filled a few years ago, and -- although the landowner supports conservation of the plant -- this area may be subject to residential development at some time in the future. The other Franklin County population on private land (EO 518) consists of only 10 clumps occurring in four of a complex of 34 ombrotrophic basin ponds. All four ponds are surrounded by nearly clearcut

forest, and two of the ponds have abundant stumps, slash, and snags within them. This population may also be threatened by residential development in the future.

A fairly large northeastern bulrush population (EO 004) occurs in Huntingdon County. This population actually consists of two wetland complexes (ombrotrophic basin marshes) separated by approximately 0.3 miles. The smaller part of the population (approximately 430 culms) occurs in three of five wetlands surrounded by swamp forest, while the larger portion of the population (approximately 1450 culms) occurs in a wetland entirely within a powerline clearing. This wetland is bisected by a jeep road. Potential threats to this population include powerline maintenance, residential development, and trampling and browsing by deer.

A population of 23 plants (EO 509) exists in a shallow emergent wetland adjacent to a kettle lake in Monroe County. This population is on private land and is threatened primarily by herbicide and fertilizer runoff, and water drawdown for residential and commercial activities.

The Union County population (EO 520) consists of only one plant in one of a cluster of small woodland ponds surrounded by recently timbered forest. There are slash piles in this pond, and the occurrence may also be threatened by agricultural runoff and residential development.

Historical occurrences

Nine historical collections are known from five Pennsylvania counties: Blair (1 occurrence), Lackawanna (3), Lehigh (3), Northampton (1), and Monroe (1). Eight of the nine sites have been field checked in an attempt to relocate *S. ancistrochaetus*; the locality data for the ninth site is too vague (Pennsylvania Natural Diversity Inventory 1990).

Four of the historical sites have been confirmed destroyed or failed: EO 504 (Lehigh County) due to agricultural activities and a slate quarry, EO 508 (Monroe County) due to succession (habitat is no longer suitable for *S. ancistrochaetus* because of encroachment of woody vegetation), EO 505 (Lehigh County) due to unknown causes, and EO 503 (Lackawanna County). In 1985, one plant was observed at the latter site in a shallow wet depression that appeared to have been bulldozed; however, no plants were observed from 1986 to 1992 (J. Kunsman, Pennsylvania Natural Diversity Index, pers.

comm.). The population may have been destroyed when the entire scrub-oak mountaintop bald burned in August of 1988. The historical specimen from this site was originally collected in 1940 from one of two, 2-3 acre bogs adjacent to the depression in which the 1985 plant occurred, but repeated surveys have failed to locate any plants in the bogs (Pennsylvania Natural Diversity Index 1991).

VERMONT

Vermont has two known populations of *S. ancistrochaetus*, located approximately 15 miles apart in Windham County. One site (EO 001) is the type locality for *S. ancistrochaetus*, which was first observed by A.E. Schuyler in 1960. The plants occur in two of several small, shallow ponds surrounded by emergent wetlands in an alluvial meadow of the Connecticut River. Several other species of *Scirpus* are also found in these wetlands.

When Schuyler revisited the site in 1979, he found that it had been flooded by beaver. The population appears to fluctuate with the hydrology of the site; the population of 69 fruiting plants in 1985 apparently declined drastically during the high water years of 1987, 1989, and 1990, and no plants were found in 1991, a drought year. Plants were relocated in 1992, the second year of low water at the site. "Water level fluctuations at this site are seasonal and yearly and are attributable primarily to beaver activity although spring flooding and subsequent drought conditions probably have some influence" (R. Popp, Vermont Natural Heritage Program, pers. comm.). This site is owned by The New England Power Company, which has entered into a cooperative management agreement with The Nature Conservancy to protect the site (Thompson 1990).

The second population (EO 002) occurs within three adjacent beaver ponds or "meadows" within a four-pond complex. This population is also located on private property. The plants occur along the edges of the meadows, in the zone of emergent vegetation. In 1992, plants were discovered at a new location in one of the ponds. At this time, however, it has not been determined "whether these are new individuals which originated from a newly exposed seed bank or whether they are formerly sterile individuals that were inhibited from flowering by the higher water levels" (R. Popp pers. comm.). The population at this site may be threatened by succession, if beaver do not periodically inundate the areas with water. The 1915 specimen from this site was originally identified as *S. atrovirens*, but was later annotated to *S. ancistrochaetus* by Schuyler (Thompson 1991).

VIRGINIA

Virginia's four extant populations occur in two different types of ponds in the Ridge and Valley Physiographic Province of the Appalachian Mountains, either: (1) shallow, oligotrophic sinkhole ponds overlying sandstone, which overlies limestone, or (2) "mountain ponds." These mountain ponds are simply natural depressions in sandstone on mountain ridges; they are not formed by the subsidence of any underlying material. All four extant populations occur on private land and are threatened by off-road vehicles and possible development.

The Rockingham County occurrence (EO 002) consists of more than 100 plants in two adjacent sinkhole ponds within a wetland complex on private land. The Nature Conservancy is negotiating an easement to protect the pond, which is threatened by off-road vehicles during dry seasons. The vigorous Bath County population (EO 003) consists of a thousands of plants in one isolated mountain pond. This site is owned by a hunt club, and a small portion of the pond has been excavated.

The Allegheny/Craig County population (EO 004) is located in an isolated, one-acre, ancient (>10,000 years) mountain pond on a 40-acre private inholding within both the George Washington National Forest and the Jefferson National Forest. Part of the site's watershed lies within Shenandoah Mountain Crest Special Interest Area, which is contained within the George Washington National Forest. Within the pond, the plants are scattered in the zone of emergent vegetation near the pond's edge (Rawinski 1989). This site may be threatened by all-terrain vehicles.

The Augusta County population (EO 005/006) was discovered in a large sinkhole pond complex (eight ponds) on private land in 1989. The plants occur in two adjacent ponds (0.2 miles apart), but are absent from the other six ponds, one of which was destroyed by a housing development, and the other of which was deepened and destroyed by a bulldozer (it is now a deep, stagnant pool). Approximately 130 plants occur in a pristine three-acre pond, along with several other rare and endangered plants, while approximately 10 plants occur in the adjacent pond (Rawinski 1989, Ludwig 1992, Virginia Natural Heritage Program pers. comm.).

The fifth occurrence (EO 001), located in a mountain pond in Rockingham County has not been observed since 1970. The area was last surveyed in 1984, but the population was not relocated. The entire area of the occurrence, however, will be protected within the "Maple Springs Special Interest Area" on the George Washington National Forest. No historical records of *S. ancistrochaetus* exist from the state.

WEST VIRGINIA

Both of West Virginia's *S. ancistrochaetus* populations are located on private land in Berkeley County. The populations are approximately one mile apart and occur in shallow, centripetally-drained sinkhole ponds perched atop flat ridges in the Ridge and Valley physiographic province. These sinkhole ponds, like the one supporting the Maryland population, are on quartzitic Oriskany sandstone, overlying Helderberg limestone (Bartgis 1992b). The sinkhole pond complexes harboring *S. ancistrochaetus* consist of at least three small (< one acre), unshaded ponds.

The largest known population of *S. ancistrochaetus* (EO 001) occurs within two ponds of a five-pond sinkhole complex. One pond supports a 7.7 m x 3.6 m stand of the plant, and the other pond is dominated by the plant, which occupies about 500 square meters. Although clumps within these ponds are very poorly defined, making population estimates difficult, in 1991 the ponds supported 2000-6000 clumps with 6,700-25,000 flowering culms, and about 58,000 non-flowering culms (Bartgis 1992a). This population is threatened by residential development (the ponds are on a tract subdivided for estate settlement), and by off-road vehicles, which run through the dried ponds during droughts (Bartgis 1992b).

The second population (EO 002) consists of over 1000 stems, with three stands in one pond, and a single stand in a second pond. The species is absent from the third pond in the sinkhole pond complex. This population is also threatened by residential development, as well as succession (invasion of woody plants), and an attempt was made in the past to drain one of the ponds with a ditch. There are no historical records of *S. ancistrochaetus* in West Virginia.

ECOLOGY and LIFE HISTORY

HABITAT CHARACTERISTICS

In general, the northeastern bulrush tends to grow in acidic to circumneutral natural ponds, shallow sinkholes, or wet depressions (wet meadows and marshes) found in hilly country (U.S. Fish and Wildlife Service 1991). It has not been found in artificial or human-disturbed habitats, such as ditches, borrow pits, or natural ponds which have been altered by ditching, draining, or dredging. *S. ancistrochaetus* sites vary geographically, from sinkhole ponds in the southern part of its range, to a variety of wetland types, including beaver ponds (marshes), wet depressions, emergent wetlands, and woodland ponds in the northern part of its range (U.S. Fish and Wildlife Service 1991). Wetlands occupied by the species in the northern part of its range do not appear to have any obvious unique habitat characteristics; indeed, many wetlands appear to have habitat suitable for the plant but do not harbor it (Thompson 1990). Common to all of the ponds occupied by *S. ancistrochaetus*, however, are water levels that fluctuate seasonally and/or annually, from inundation (in late winter and spring) to saturation (in summer and late fall). Depending on the wetland, fluctuations may be caused by beaver activity and/or weather patterns. Because it appears that the wetlands supporting *S. ancistrochaetus* are fed primarily by surface water, water table fluctuations probably have only a minor influence on *S. ancistrochaetus* habitat. This species also seems to require ample sunlight; plants are usually absent from the highly shaded perimeter of woodland ponds.

The ponds supporting *S. ancistrochaetus* are usually part of relatively small (usually less than one acre) wetland complexes of clustered ponds in which each pond is separated from the others by a few hundred feet or yards or less (U.S. Fish and Wildlife Service 1991). When *S. ancistrochaetus* is found in such a wetland complex, it tends to occupy only one to three ponds (often adjacent) within the complex. For site-specific habitat characteristics, refer to the preceding section and Table 3.

The northeastern bulrush may be found growing at the water's edge of the emergent zone, or may be found several feet away from water, in a few centimeters of water, or in deep water (0.3-1.0 meter), depending on seasonal fluctuations in water level (Thompson 1991). This apparently wide zone of distribution along and on either side of the water's edge probably indicates that *S. ancistrochaetus* has adapted to, and is tolerant

of, the seasonal fluctuations in water level characteristic of the ponds in which it is found. A.E. Schuyler (pers. comm.) notes that the northeastern bulrush may be adapted to naturally fluctuating water regimes and may, as a consequence, face little competition from competitors. It may, therefore, face increased competition and eventual replacement and elimination if its habitat becomes consistently wetter or drier (i.e., if the hydrological regime is changed).

ASSOCIATED SPECIES

There is considerable variety in the species associated with *S. ancistrochaetus*, not only across its range, but also among wetlands in the same physiographic area. A few species, however, including *Dulichium arundinaceum*, *Glyceria canadensis*, *Triadenum virginicum*, and *Scirpus cyperinus*, are common to several sites (Thompson 1991). Associates in the northern part of the bulrush's range (north of Maryland) include *Polygonum hydropiperoides*, *Spiraea latifolia*, *Equisetum fluviatile*, *Lysimachia terrestris*, *Thelypteris palustris*, *Glyceria acutiflora*, *Carex vesicaria*, *Carex crinita*, *Asclepias incarnata*, *Puccinellia fernaldii*, *Juncus effusus*, *Acer rubrum*, *Carex canescens*, *Osmunda regalis*, and *Eriophorum virginicum* (Rawinski 1986).

Common associates in the southern portion of the bulrush's range include: *Glyceria septentrionalis*, *Glyceria striata*, *Glyceria acutiflora*, *Lycopus americanus*, *Ludwigia palustris*, *Cephalanthus occidentalis*, *Polygonum punctatum*, *Boehmeria cylindrica*, *Potamogeton pulcher*, *Carex lupulina*, *Bidens frondosa*, and *Ilex verticillata*.

Other members of the genus *Scirpus*, including *S. atrovirens*, *S. cyperinus*, *S. pedicellatus*, *S. hattorianus*, *S. expansus*, *S. torreyi*, and *S. atrocinctus* may be found in the same wetland complex, but rarely in the same pond, occupied by *S. ancistrochaetus* (U.S. Fish and Wildlife Service 1991, Thompson 1990). Investigators have noted that *S. cyperinus* is the only congener that commonly co-occurs with *S. ancistrochaetus* (R. Bartgis and J. Kunsman pers. comm). In only a few sites (e.g., both Vermont sites) does *S. ancistrochaetus* co-occur with *S. atrovirens* and *S. hattorianus*, species with which it also hybridizes. In Pennsylvania, Maryland and West Virginia, *S. atrovirens* often occurs in wet ditches, trails, and roads adjacent to *S. ancistrochaetus* ponds, however, *S. atrovirens* has never been observed to co-occur with *S. ancistrochaetus* at these sites.

POPULATION DEMOGRAPHY

Very little is known about the life history and reproductive biology of the northeastern bulrush. This paucity of information is attributed to the following factors: (1) the northeastern bulrush is a recently described species, so investigators have had relatively little time to study its ecology, (2) it is not easily identified, (3) its presence at a site may be unpredictable from year to year, (4) it is not a showy plant, and (5) it occurs in widely scattered, isolated wetlands.

In assessing the survey data from various states, it appears that *S. ancistrochaetus* experiences drastic fluctuations in population size from year to year (in some cases, the plants have "disappeared" for several years before re-emerging). At this time, however, it is not clear whether these fluctuations are real or perceived. The major difficulty seems to be in identifying the non-sexually reproducing individuals in the population, i.e., plants lacking flowering/fruiting culms. Therefore, most investigators report population sizes in numbers of clumps or plants with flowering/fruiting culms, or in total numbers of flowering/fruiting culms. *S. ancistrochaetus* may, indeed, experience drastic population fluctuations in response to various environmental factors, but if, in fact, it also responds to changes in its environment by altering -- or skewing -- its reproductive strategy from asexual to sexual reproduction (or vice versa), population fluctuations may be exaggerated by failing to count or assess the vegetatively-reproducing segment of the population. This indicates an urgent need for a method of easily identifying seedlings and vegetatively-reproducing individuals in the field, and the need to mark and monitor individual plants to obtain more accurate information about population demography.

It is not known how hydrological fluctuations or other environmental variables affect population size or density of *S. ancistrochaetus*, although extremely high water levels seem to correspond to a decline in population size (number of clumps, as well as number of flowering/fruiting culms). Other ecological factors necessary for the maintenance of existing populations or establishment of new populations also remain unknown.

REPRODUCTIVE BIOLOGY

The reproductive biology of *S. ancistrochaetus* is not well understood. While it does reproduce both sexually and vegetatively, the relative importance of each, especially in relationship to habitat conditions, has not been investigated. Observations suggest,

however, that it most often reproduces vegetatively (by nodal and basal shoots), and that this is the primary means of recruitment, at least in established populations (U.S. Fish and Wildlife Service 1991; Bartgis 1992a, 1992b; J. Kunsman pers. comm.). This observation appears to be supported by the clumping of stems (evidence of cloning) and the aggregation of clumps or plants in the populations that have been surveyed. Vegetative reproduction occurs in the form of new plants (bulblets or nodal shoots) developing from the nodes and culms of recumbent stems (Bartgis 1989, Thompson 1990, U.S. Fish and Wildlife Service 1991). The parental culm dies by autumn, leaving the nodal shoots to root themselves as independent plants. Bulblets can also form in the inflorescence itself (Bartgis 1992b). In addition, basal shoots can form from the rhizomes at the base of the culms (Schuyler 1967).

Sexual reproduction has been observed in all populations, in the form of flowering and/or fruiting culms; however, evidence of sexual recruitment (seedling establishment) has not been reported thus far in status reports. Germination occurs on or in the immediate vicinity of the seedhead and has only been noted on seedheads that have fallen over and been submerged in water (Bartgis 1992a). Bartgis noted that germination peaks in late March in West Virginia, and a much smaller cohort of seeds germinates in the fall. He also noted, in the same report, that seedlings readily float, suggesting that sexual recruitment may be important in dispersal and the establishment of new populations. Seedling mortality, however, is quite high (sometimes approaching 100%) and sexually produced plants seem to have less vigor than do vegetatively produced plants.

R. Bartgis (pers. comm.) further suggests that the absence of isolated individuals within ponds may indicate that sexual recruitment is a very rare event. If this is true, it may explain why the northeastern bulrush is seldom found in more than one or two ponds within a wetland complex; its ability to colonize new or even adjacent sites appears to be quite limited. Of course, another explanation may be that there are subtle yet important microhabitat differences (possibly hydrological) among the ponds, making some of them unsuitable for occupation by *Scirpus ancistrochaetus*.

Hydrological fluctuations appear to affect both sexual and asexual reproduction in *S. ancistrochaetus*. Bartgis (1992a) reported that both sexual and asexual recruitment appeared to be significantly reduced in the Maryland and West Virginia populations during the 1991 drought, and suggested that during drought events, basal shoots and parental plants probably maintain the population.

In addition, flooding may inhibit sexual reproduction. At the type locality in Vermont (EO 001), the population endured beaver-flooding during the 1970s, but produced only a few flowering culms per year. In 1985, however, when normal water levels were restored, several hundred flowering culms were observed (Rawinski 1986). In 1989, the few plants that were observed had unusually small fruiting heads, but the ones that were recumbent in the water were proliferating at the nodes (reproducing vegetatively) (Thompson 1991). At one of the Clinton County sites in Pennsylvania (EO 001), no plants were evident from 1986 to 1990; however, during the drought year of 1991, two clumps with several flowering culms were evident on a previously floating mat of vegetation now resting on the bottom of the pond (Pennsylvania Natural Diversity Inventory 1991).

There are several possible explanations for this phenomenon. As noted before, *S. ancistrochaetus* may alter its reproductive strategy from sexual to asexual in response to changes in the hydrological regime; for instance, lower water levels seem to promote sexual reproduction. In some populations, it is evident that the strategy is not "all or nothing": signs of sexual and vegetative reproduction are often observed in the same population, and by the same plants at the same time. Interestingly, however, the Virginia populations have shown no signs of vegetative reproduction (Rawinski 1989). Considering the difficulty in identifying plants lacking flowering/fruiting culms, the total reproductive effort of any given population has not yet been determined. A scarcity of flowering/fruiting culms may indicate that habitat conditions do not currently favor sexual reproduction, or that the reproductive strategy has switched to primarily vegetative reproduction. In any event, the persistence of *S. ancistrochaetus* at sites with known hydrological fluctuations indicates that the plant has a reproductive strategy adapted to these fluctuations.

Another aspect of reproduction meriting investigation is seed viability and dispersal. There are some indications from seed germination trials that the seeds may remain viable for many years, suggesting the possible existence of a large seedbank (W.E. Brumback, New England Wild Flower Society, pers. comm.). No information is available, however, on the longevity or viability of seeds under natural conditions, and, because the fruit walls are delicate, there is some question as to the seedbank capacity of the plant (A.E. Schuyler). Also, while it is assumed that seeds may disperse by wind or water (especially if flooding occurs before the seeds have become lodged in the substrate), nothing is known about the effectiveness of seed dispersal under natural conditions. Due to the presence of barbs, the seeds readily adhere to clothing and would presumably adhere well to fur (R. Bartgis and J. Kunsman pers. comm.). Wildlife that may act as dispersal agents, including waterfowl and

beaver, are down in numbers from historical levels in many areas. While the northeastern bulrush appears to be a well-equipped disperser (i.e., its seeds are designed for dispersal and readily germinate), its distribution indicates that it may be a conservative plant -- it stays in place, exhibiting almost a non-dispersal capacity in terms of establishment.

THREATS TO THE SPECIES

ANTHROPOGENIC THREATS

The most serious and immediate threats faced by this species are human-related activities that lead to the destruction or modification of its habitat. The 20 populations located on private land are especially vulnerable to destruction or degradation through wetland filling, draining, and dredging for development, agriculture, and recreation purposes (U.S. Fish and Wildlife Service 1991). Further, existing Federal and state laws and regulations are inadequate to fully counter these threats. Little information is available on historical occurrences of *S. ancistrochaetus*, but it appears that at least two of the four extirpated populations in Pennsylvania were destroyed by human-related activities (agriculture and development).

While development (especially residential) is a potential threat to all populations located on private land, the threat seems to be most immediate in West Virginia and Virginia. The two populations in West Virginia are located in areas of rapid residential development, and both occurrences are surrounded by subdivided lands currently being marketed for housing developments (Bartgis 1989, U.S. Fish and Wildlife Service 1991). Rawinski (1990) noted that during the 1989 status survey in Virginia, nine of 21 ponds believed to contain suitable habitat for the northeastern bulrush had been destroyed (dredged or diked) or degraded (partially filled, excavated, or eutrophied from agricultural runoff).

Any activity that could alter the natural hydrological regime of a *S. ancistrochaetus* site should be considered a potential threat to the continued existence of that population. Drawdown of the water table by residential developments and industrial activities may adversely affect northeastern bulrush populations. Effects on the population in Monroe County, Pennsylvania, which is surrounded by residential developments and is adjacent to a

sand and gravel quarry, need to be determined. Residents of this area have noted that the water level in the lake (and associated wetland occupied by *S. ancistrochaetus*) has dropped several feet over the past few years, but no one has been able to ascertain the cause of the drop.

Northeastern bulrush populations could also be adversely affected by land use practices that disrupt or alter the flow of surface water into wetlands in which they occur. For example, timber harvesting near northeastern bulrush populations may alter the natural hydrological regime of ponds occupied by the bulrush. The loss of a large number of trees near these ponds may significantly raise the water levels in the ponds, because the water that was previously transpired by the trees now remains in the soil or washes into low-lying areas such as ponds. The silt load entering the ponds may also greatly increase because of the soil disturbance resulting from timber harvest and/or the loss of trees which would normally catch and trap sediment. Further, the soil disturbance and increased light availability associated with timber harvest encourages the invasion of exotic plants, which may directly compete with native species such as the northeastern bulrush.

Other threats, such as erosion, sedimentation, and runoff from agricultural lands and construction sites, may be less direct but potentially as serious. Portions of a northeastern bulrush population in Pennsylvania were degraded by sediments from the erosion of an adjacent hillside undergoing extensive landscaping. Upon notification of the situation, the landowner erected an erosion and sedimentation control fence to protect the wetland. Eutrophication induced by agricultural runoff (fertilizers), documented as a threat in Virginia (Rawinski 1990), is a potential treat to any population bordering agricultural fields or residential areas. Herbicides are an associated threat common to these areas.

Other human-related threats that may damage northeastern bulrush populations include: logging roads (close to sites in Maryland, Pennsylvania, and New Hampshire), fire roads (adjacent to a site in Pennsylvania), and all-terrain vehicles. Most of the sites in which *S. ancistrochaetus* occurs dry out partially during droughts, allowing vehicular access to the habitat (U.S. Fish and Wildlife Service 1991). The use of ATVs in this habitat may not only destroy the vegetation, but could degrade the habitat through soil compaction and/or rutting. Off-road vehicle use was documented at a West Virginia site during a dry period, although the northeastern bulrush plants were undamaged (Bartgis 1989).

As far as is known, the northeastern bulrush has not been subject to taking for commercial, recreational, scientific, or educational purposes. However, were taking to occur, the effect could be devastating, particularly to small populations.

NATURAL THREATS

Because most northeastern bulrush occurrences are very small (less than 0.25 acres in stand size) and isolated, they are particularly vulnerable to loss by stochastic events, such as tree-falls, floods, severe droughts, and insect or disease attack. Other natural threats include fire, succession, beaver, and long-term disruption of natural water level fluctuations.

The population in Lackawanna County, Pennsylvania may have been destroyed in 1988 by a fire that burned the entire mountaintop bald where the plant occurred; no plants were observed in 1988, 1989 or 1991 (Pennsylvania Natural Diversity Inventory 1991). For most *S. ancistrochaetus* occurrences, however, fire would only be a threat if and when the associated wetland were dry enough to burn at the time the fire occurred. While this scenario may occur very infrequently, land managers should be aware of the possibility.

One of the four historical occurrences in Pennsylvania was apparently lost when the encroachment of woody vegetation made the habitat unsuitable by *S. ancistrochaetus* (Pennsylvania Natural Diversity Inventory 1991). It has been speculated that succession may threaten populations in Maryland and West Virginia (Thompson 1991).

Flooding caused by beaver has been suggested as a threat to northeastern bulrush populations in Vermont (Thompson 1990) and Pennsylvania (Pennsylvania Natural Diversity Inventory 1991). However, while flooding does seem to inhibit sexual reproduction, long-term impacts are unknown. Beaver populations are larger now than they were at the turn of the century, when overtrapping had extirpated or vastly reduced populations throughout much of the United States. Considering the present occurrence of the bulrush in beaver-influenced habitats, as well as the likely cohabitation of these areas by both beaver and bulrush over long periods (possibly centuries), it seems unlikely that beaver activity would pose a threat to most bulrush populations. Conversely, it is likely that beaver-influenced wetlands provide the fluctuating hydrological regime favorable to and/or necessary for the existence of the bulrush, similar to the fluctuating water levels characterizing sinkhole ponds in the southern portion of the bulrush's range.

Another threat inherent in small, isolated populations is inbreeding, with subsequent loss of genetic diversity. Inbred populations become less viable over long time periods, because they lack the genetic variability necessary to adapt to changes in their environment. Because of the apparently high incidence of clonality, low success of sexual recruitment, and the small, isolated nature of northeastern bulrush populations, this species seems particularly vulnerable to a loss of genetic diversity. The degree and implications of genetic depression on this species have not been determined, and may vary from population to population.

CONSERVATION MEASURES

CURRENT LEGAL PROTECTION

By virtue of its status as a Federally and state listed species, as well as being a wetland plant, *S. ancistrochaetus* benefits from (1) the protection offered by the Endangered Species Act of 1973, as amended; (2) the various endangered species laws enacted in the States of Maryland, Massachusetts, New Hampshire, Pennsylvania, Vermont, and Virginia; and (3) a number of wetlands regulations. These laws and regulations are described in the Appendix to this plan.

The degree of legal protection available to this and other listed plants is insufficient to fully safeguard populations on private lands and on those state lands that may not be covered under state endangered species laws. In particular, without acquisition or easements on all northeastern bulrush sites, regulatory protection currently in place is not sufficiently strong to ensure the continued maintenance of the species if the provisions of the Federal Endangered Species Act were to be removed through delisting.

SITE PROTECTION

Currently, only one of the 20 northeastern bulrush populations on private land receives additional protection under a conservation or management agreement. This Vermont population (EO 001) occurs on property owned by a power company, which has entered into a management agreement with The Nature Conservancy to protect the site.

Similar efforts should be taken to secure the protection of all northeastern bulrush populations on private lands.

One Pennsylvania population (EO 001) receives additional protection due to its location within a designated "natural area" within a State Forest. All Pennsylvania occurrences on State Forest lands (EO 005, 007, 008, 009, 511, 513, 515, and 516), as well as any additional occurrences on State Forest land, should receive the added protection of being designated as "Public Plant Sanctuaries."

One possibly extant Virginia site (EO 001) receives the added protection of occurring within a "Special Interest Area" on the George Washington National Forest. Activities such as timber harvest and ATV use are prohibited within these areas.

SURVEYS TO LOCATE ADDITIONAL POPULATIONS

In Maryland, Massachusetts, Vermont, and West Virginia, most of the potential habitat for *S. ancistrochaetus* has been surveyed, and in Virginia, approximately half of the suitable habitat has been surveyed (U.S. Fish and Wildlife Service 1991). Due to the nature of the plant, and prior difficulties experienced in identifying non-sexually reproducing forms of the plant, additional surveys of all potentially suitable habitat are warranted.

Additional surveys conducted in Pennsylvania in the summer of 1992 revealed the presence of 17 previously undiscovered populations. Much potentially suitable habitat remains to be identified and surveyed in Pennsylvania.

RESEARCH EFFORTS

In 1991, R. Bartgis of the Maryland Natural Heritage Program initiated an intensive study of two northeastern bulrush populations (West Virginia EO 001 and Maryland EO 001), to describe the species' life history and document demographic trends and changes. The Maryland population will be completely censused (number of clumps, flowering stems, and non-flowering stems), and 50 individual plants will be tagged and tracked for reproductive success throughout the growing season (Bartgis 1992a). The West Virginia population will be sampled to determine number of clumps, flowering culms, nodal shoots, and basal shoots. Plots were established in both populations to track the success of

seedling establishment (Bartgis 1992a). "The existing research projects in Maryland and West Virginia also involve correlating spatial and temporal patterns in water depth with bulrush density and reproductive success, spatial patterns in shading with bulrush distribution, impacts of monitoring activities on bulrush density, and determining life history traits for the species" (R. Bartgis pers. comm.).

Permanent monitoring plots were established at both Vermont sites in 1992 to facilitate relocating individual plants in order to track reproductive success and demographic trends.

Propagation of the plant by seed has been attempted under both casual and experimental conditions. A few botanists familiar with the species have successfully germinated seeds (A.E. Schuyler and R. Bartgis pers. comm.). At Garden in the Woods in Massachusetts, W.E. Brumback (pers. comm.) has successfully germinated 4-5 year old seeds of *S. ancistrochaetus* (taken from herbarium specimens).

RECOVERY STRATEGY

The primary strategy for recovery of *Scirpus ancistrochaetus* involves restoring the species' rangewide distribution through protection of known extant populations and their habitat, as well as conducting searches for additional populations. In order to ensure long-term viability, investigations into ecological requirements will be conducted, possibly leading to management of the species.

PART II: RECOVERY

RECOVERY GOAL

The goal of the *Scirpus ancistrochaetus* recovery program is to protect and maintain the species and its habitat, enabling the eventual removal of the species from the Federal list of Endangered and Threatened Animals and Plants. This will be accomplished by preventing habitat destruction and deterioration at known *S. ancistrochaetus* sites, and possibly by finding additional populations. Pending more information about its life history and habitat requirements, the recovery plan will address only those conditions and recovery activities needed to reclassify the species from endangered to threatened status.

RECOVERY OBJECTIVE

The objective of this recovery plan is to reclassify *Scirpus ancistrochaetus* from endangered to threatened status. Reclassification will be considered when the following conditions have been met:

1. Long-range protection is secured for a total of 20 populations. These populations should be protected from present and foreseeable anthropogenic and natural threats that may interfere with their survival. Adequate protection measures comprise land acquisition, conservation easements, and measures to protect the local watershed in which the species is found.
2. Annual monitoring over a 10-year period shows that a sample of 20 representative populations are stable or increasing (expanding). General population, reproductive, and habitat trends should indicate a capacity for being self-sustaining in the wild over the long term, with little or no management intervention.
3. Life history and ecological requirements are understood sufficiently to allow for effective protection, monitoring, and, as needed, management.

RECOVERY TASKS

1. Protect all known extant populations and their habitat.
Most of the known populations occur on private lands and are currently threatened by habitat destruction or deterioration.
 - 1.1 Identify essential habitat. Local watersheds and pond complexes associated with those wetlands harboring *S. ancistrochaetus* will be delineated, and land uses within the watersheds will be identified (in order to assess and track threats). In light of the threats posed by land use changes in the vicinity of its habitat, a buffer of at least 150-200 feet is recommended around all ponds, pond complexes, and wetlands occupied by the northeastern bulrush.
 - 1.2 Identify, monitor, and alleviate threats to each population. Each population will be carefully monitored to assess potential threats as described in Part I, and to identify any new or unforeseen threats to the population or its habitat. The magnitude and immediacy of these threats should be monitored on a site-specific basis in order to implement proactive management and protection strategies.
 - 1.3 Secure permanent protection for known populations. Private and public conservation organizations will consider land acquisition or conservation easements for populations on private property. Voluntary cooperative agreements may also be secured. These efforts should allow for protection and active management of the species. First priority will be given to the two West Virginia populations, which are in need of immediate protection.
 - 1.4 Seek cooperation and active support of private landowners and public land managers. Landowners will be informed about the presence of *S. ancistrochaetus* on their property, and apprised of the biological, ecological, and legal status of the species. Landowners and interested parties will be provided an information packet and/or brochure, as developed in Task 9. Voluntary support in protecting and managing populations, as well as in alleviating the threats identified in Task 1.2, will be sought.

1.5 Coordinate with Federal, state, and local regulatory agencies to ensure compliance with laws protecting the species. The northeastern bulrush is protected under the Federal Endangered Species Act of 1973, as amended, and under individual State endangered and threatened species laws and regulations. The wetland habitat occupied by the northeastern bulrush receives some degree of protection under Federal and state wetland laws and regulations. However, many ponds occupied by the northeastern bulrush do not appear on USGS topographic maps or National Wetlands Inventory maps, and therefore, could easily be missed during cursory agency reviews of projects. The species will be best protected from a regulatory standpoint in states where (1) all known *S. ancistrochaetus* occurrences are documented in a state heritage database, and (2) the review of all projects and activities that may impact wetlands includes a review of this database for the presence of listed species.

1.51 Coordinate with the U.S. Army Corps of Engineers to ensure that permits issued do not jeopardize any *S. ancistrochaetus* populations. Issuance of a public notice (in all Corps Districts containing or likely to contain populations of *S. ancistrochaetus*) will be encouraged. This notice should detail information about the legal status of the northeastern bulrush, and measures necessary to ensure public compliance with Federal wetland protection laws.

The Corps will be urged to take an active role to ensure that areas that have, or are likely to have, populations of *S. ancistrochaetus* come under close scrutiny when permits for projects within these areas are reviewed. The Corps will be encouraged to take discretionary authority over all areas (at the USGS quadrangle level or the township level) known to support this species, and to coordinate permit reviews in these areas with the U.S. Fish and Wildlife Service.

1.52 Coordinate with appropriate state agencies and Natural Heritage Programs to ensure that *S. ancistrochaetus* receives the full protection of applicable state laws. The northeastern bulrush receives some degree of protection from take under most state

endangered species laws; however, the primary threat is to the species' habitat. In some states, its habitat may receive some protection indirectly through state wetland regulations. All appropriate regulatory avenues should be utilized to protect the species. Regulatory agencies that review and/or issue permits that may adversely affect northeastern bulrush habitat should be familiar with the known occurrences of the species, and should recommend surveys (by a qualified botanist) of those areas likely to support additional populations of the species before permits are issued.

2. Conduct rangewide searches in areas of suitable habitat for additional populations.

Status surveys conducted to date indicate that population sizes at most sites may fluctuate dramatically from year to year. In addition, the flowering/fruitle culms (the basis for current population counts), may not be produced at a site for several years, leading investigators to overlook extant populations. Because of these difficulties, the following tasks are warranted:

2.1 Resurvey sites thought to have suitable habitat. All sites that appeared (at the last survey) to have habitat suitable for the species, including all historical sites, will be resurveyed for the presence of *S. ancistrochaetus*.

2.2 Identify potentially suitable habitat for additional surveys.

2.3 Survey potential sites for the presence of *S. ancistrochaetus*. This will be followed up with Task 2.1.

2.4 Verify, catalogue, monitor, and protect any additional populations. For newly discovered populations, Tasks 1.1-1.5 and Task 4.2 will be completed.

3. Develop reliable census techniques.

Methods that will allow investigators to accurately and consistently monitor *S. ancistrochaetus* populations are needed.

3.1 Develop consistency in the definition of plant terms. Investigators will define and agree upon the terms "plant" and "clump" as they relate to this species. These terms may be elucidated by the completion of Task 7.1.

- 3.2 Detail methods to identify non-sexually reproducing individuals readily in the field. In order to understand and assess demographic trends and changes (Task 4), and reproductive strategies (Task 5), investigators must be able to readily identify all forms of the plant, including mature plants and seedlings in the field. Investigators report that identification of *S. ancistrochaetus* is more difficult when other *Scirpus* species occur at the same site.
- 3.3 Describe methods for measuring the size and health of individual plants. Attributes such as height and seed production will be assessed in order to understand variation in performance and survival within and among populations.
- 3.4 Develop consistent, reliable censusing techniques for use throughout the species' range. Standardization of censusing techniques will allow valid comparisons of population size and status within and among populations, and from year to year. All sites selected for Tasks 4.1 and 4.2 should be mapped, i.e., the pond(s) should be mapped relative to surrounding habitat, and the location of the bulrush stand(s) within the pond(s) should be mapped. It is also suggested that permanent stakes (e.g., PVC pipes) be placed in 4 to 8 locations along the perimeter of the bulrush stand, and also indicated on the map. By annually examining the position of the stand relative to the permanent markers, investigators will be able to roughly determine whether the stand size is increasing, stable, or decreasing.
- 3.41 Develop techniques and methods for quantitative, detailed monitoring of five study populations. (See Task 4.1) Transects and/or quadrats will be used to measure population size by counting flowering culms, non-flowering culms, and vegetative plants or clumps (where feasible) to determine demographic trends and reproductive success. Quantifiable data may include, but are not limited to:
- areal coverage (m^2) and density of the population*
 - number of plants or clumps
 - number of culms (stems)*
 - number of non-flowering culms/unit area*

- number of sexually-reproducing plants
- number of flowering-fruiting culms/unit area*
- number of asexually-reproducing plants
- number of bulblets/plant
- number of plants exhibiting signs of sexual and asexual reproduction
- number of seedlings produced/quadrat, counted in spring, summer, and fall
- seed production (# seeds/seedhead)
- hydrological state (quantified) of the immediate habitat surrounding the plants*

* Data that, at a minimum, should be obtained at least annually for each study population.

3.42 Develop the techniques and methods needed to monitor 20 other representative populations. (See Task 4.2) Quantitative data and qualitative observations should include, but are not limited to, the following:

- areal coverage and density
- type of reproduction exhibited and its relative prominence (e.g., primarily vegetative)
- hydrological conditions at time of survey
- photographic documentation of site and stand condition

4. Monitor the health, size, and reproductive status of each population.

The censusing and sampling techniques and criteria developed in Tasks 3.1-3.4 will be implemented for selected sites. Investigators who monitor *S. ancistrochaetus* populations should note that it is very difficult to work in dense stands of the plant without having an impact. "In a dense population, the fallen culms form a dense, thatch-like patch of overlapping horizontal stems. Walking through a site once the parental culms fall over results in many culms being broken up before the nodal shoots are physiologically independent" (Bartgis 1992a). Investigators should, therefore, take great care to minimize trampling of plants during surveys.

4.1 Select and intensively monitor five study sites that occur across the species' range and represent different habitat types and population sizes. These sites will be monitored and sampled (at least annually) to obtain demographic

data and trends, and information on environmental conditions according to criteria established in Task 3.41.

- 4.2 Select and monitor 20 other representative sites across the species' range. Twenty sites will be selected and monitored (at least annually) to obtain general population and habitat information (see Task 3.42 for criteria). Information obtained should be specific enough to assess changes in population size and health.

5. Investigate the life history and reproductive strategy of *S. ancistrochaetus*.

- 5.1 Determine and assess demographic characteristics of the five study populations. Concomitant with Task 4.1, within the study sites, a sample of individual plants representing all growth stages (seedlings, bulblets, reproductive and non-reproductive mature plants) will be marked and monitored to quantify plant growth, health (size), survivorship, reproductive strategy (sexual, asexual, or both), and reproductive effort.
- 5.2 Investigate the relative importance of sexual vs. asexual (vegetative) reproduction and recruitment. Using data collected from Tasks 4.1 and 4.2, variation in reproductive strategy and effort based upon environmental and habitat conditions (light, hydrology, hydrological fluctuations, density of plants, etc.) will be determined.
- 5.21 Determine the success and frequency of sexual reproduction and sexual recruitment (seedling establishment). This will be determined using a step-down investigative process:
- Are seedlings appearing in the field? *IF NOT . . .*
Are seeds being produced and are they fertile? *IF NOT . . .*
Are fruits being produced? *IF NOT . . .*
Are flowers being produced?
Are pollinations occurring?
IF NOT . . . WHY?

Note that, among other things, abortive seeds and sterile pollen may indicate a hybrid cross between *S. ancistrochaetus* and another *Scirpus* species.

- 5.22 Determine how environmental and habitat conditions affect sexual reproduction and recruitment. Determine what environmental conditions favor or stimulate sexual reproduction (the production of flowering/fruiting culms) and what conditions inhibit sexual reproduction. The microhabitat and biological conditions (hydrological, temperature regime, light, soil condition, degree of competition, density of plants, etc.) necessary for seedling establishment (sexual recruitment) should also be investigated to better understand the life history of the species.
 - 5.23 Determine the success and frequency of asexual reproduction and recruitment. When, how, and how successfully nodal shoots (bulblets) and basal shoots become established will be investigated.
 - 5.24 Determine how environmental and habitat conditions affect vegetative reproduction and recruitment. The environmental conditions that stimulate plants to proliferate at the nodes (produce bulblets or nodal shoots) will be determined. In addition, the conditions (hydrological, plant density, light, etc.) under which nodal shoots and basal shoots become established will be investigated.
- 5.3 Experimentally investigate the species' habitat requirements for recruitment (sexual and asexual).
- 5.31 Under controlled conditions, determine requirements for seed germination and nodal shoot establishment. These experiments would be conducted in a greenhouse and would eventually lead to the development of successful techniques to propagate plants from seeds, nodal shoots and/or basal shoots. Seeds and shoots should be collected sparingly, and initially only from the largest populations of the species. NOTE: investigators must obtain the necessary permits when collecting any part of *S. ancistrochaetus*.

- 5.32 Conduct controlled field experiments to determine the habitat specificity and recruitment success of *S. ancistrochaetus*. Seeds, propagated seedlings, and/or shoots (with evident roots) from a particular pond supporting *S. ancistrochaetus* may be transplanted into an adjacent pond(s) within the same pond complex, but lacking *S. ancistrochaetus* plants. Genetic material, i.e., seeds, seedlings, shoots, etc., from a different population must not be introduced into a wetland complex already supporting a *S. ancistrochaetus* population. Habitat specificity and recruitment success may be investigated by planting or transplanting seeds, seedlings, and/or shoots along existing hydrological gradients. Other variables (time of year, temperature, shading, soil condition, etc.) may also be investigated.
- 5.4 Investigate the significance of seed banking and seed dispersal. The size and viability of the seed bank will be determined. In addition, the degree to which seeds disperse to adjacent ponds lacking the species will be investigated.
6. Determine the habitat characteristics and environmental requirements of the species.
- 6.1 Characterize the habitat of the five study sites. This will include, but is not limited to, hydrological regime, temperature (air, soil, water), soil type and Ph, degree of shading, aspect, elevation, and associated plants.
- 6.2 Determine to what degree, and under what conditions competitors may threaten *S. ancistrochaetus*. The degree of competition from congeners and other plant species (native and exotic) will be investigated to determine whether or not they pose a threat to *S. ancistrochaetus*.
- 6.3 Investigate the effects of land management practices on the northeastern bulrush. Most sites are located within forested areas subject to timber harvest, yet it is unknown how timber harvesting around ponds may affect the species. The effects of this practice on the hydrology of the ponds, as well as siltation and the potential for invasion of competitors (native and

exotic) -- will be investigated -- particularly at sites that have recently been, or are scheduled to be timbered, so appropriate management recommendations can be formulated and refined (e.g., width of buffer necessary to protect the species).

- 6.4 Investigate the effects of beaver activities on hydrological regime and demography of the bulrush. Beaver activities and water levels will be monitored, and effects on the population level and reproductive strategy of the northeastern bulrush will be determined.

7. Investigate the genetic variability and viability of the species.

- 7.1 Evaluate the genetic identity of individual plants. Determine whether each clump, or possibly each stand represents one plant (consisting of several clones). Are the individuals in a stand or clump genetically identical and/or do they share interconnecting root systems?
- 7.2 Determine the degree of intra- and inter-population genetic variability. Conservation of genetic diversity across the species' range is imperative to its long-term survival.
- 7.3 Determine to what extent seed viability varies with the extent of clonality in populations. Extensive clonality has the potential to lower genetic diversity over time. Low seed viability may be a sign of inbreeding and subsequent depression of sexual reproduction. Completion of this task depends on the development of successful seed germination techniques (Task 5.31).

8. Secure, and store or propagate genetic material from each genotype.

- 8.1 Store a small sample of seeds from each genotype (population). A possible storage facility is the National Seed Bank in Ft. Collins, Colorado, which freezes and stores seeds.
- 8.2 To safeguard the smallest populations, cultivate nodal shoots or seeds and maintain in a secure environment. A possible propagation facility is Garden in the Woods (New England Wild Flower Society) in Massachusetts.

9. Develop an information brochure/packet for distribution to landowners, managers, and other interested parties.

This packet will be used as a public relations/education/conservation document related to the species specifically, and rare species conservation and wetland protection generally. The packet should provide an easily understood explanation of applicable Federal and state laws related to the species. It should also include the addresses, phone numbers, and responsibilities of contact agencies.

REFERENCES and LITERATURE CITED

- Bartgis, R.L. 1989. Status survey summary: *Scirpus ancistrochaetus* in Maryland and West Virginia. Unpub. report by the Maryland Natural Heritage Program for The Nature Conservancy. 8 pp.
- _____. 1992a. Ecologist, Maryland Natural Heritage Program. Written correspondence to C. Copeyon regarding study of life history characteristics of the northeastern bulrush in Maryland and West Virginia.
- _____. 1992b. The endangered sedge *Scirpus ancistrochaetus* and the flora of sinkhole ponds in Maryland and West Virginia. *Castanea* 57:46-51.
- Brumback, W. 1992. Conservation Director, New England Wild Flower Society. Telephone conversation with C. Copeyon.
- Crow, G.E. 1982. New England's rare and endangered vascular plants. U.S. Dept. of the Interior. Fish and Wildlife Service, Northeast Region. Washington, DC. 130 pp.
- Gleason, H.A. and A. Cronquist. 1991. Manual of vascular plants of the northeastern United States and adjacent Canada. 2nd edition. The New York Botanical Garden, New York.
- Massachusetts Natural Heritage Program. 1990. Status information from files.
- Mitchell, R.S. and C.J. Sheviak. 1981. Rare plants of New York State. Bulletin No. 445, New York State Museum.
- Pennsylvania Natural Diversity Inventory. 1991. Status information from files.
- _____. 1992. Status information from files.
- _____. 1993. Status information from files.
- Rawinski, T.J. 1986. Range-wide status summary: *Scirpus ancistrochaetus*. Unpub. report by the Eastern Heritage Task Force, The Nature Conservancy. 5 pp.
- _____. 1989. Northeastern bulrush (*Scirpus ancistrochaetus*) in Virginia: Results of the 1989 status survey. Unpub. report by the Eastern Heritage Task Force, The Nature Conservancy for the U.S. Fish and Wildlife Service, Region 5. 42 pp.
- _____. 1990. Final status survey report: distribution and abundance of northeastern bulrush (*Scirpus ancistrochaetus*). Unpub. report by the Eastern Heritage Task Force, The Nature Conservancy for the U.S. Fish and Wildlife Service, Region 5. 5 pp.
- Schuyler, A.E. 1962. A new species of *Scirpus* in the northeastern United States. *Rhodora* 64:43-49.

- _____. 1963. Notes on five species of *Scirpus* in eastern North America. *Bartonia* No. 33:1-6.
- _____. 1967. A taxonomic revision of North American leafy species of *Scirpus*. *Proc. of the Acad. of Nat. Sci. of Phil.* Vol. 119:295-323.
- _____. 1975. Chromosome numbers of some eastern North American species of *Scirpus*. *Bartonia* 44:27-31.
- Thompson, E.H. 1990. Vermont status report: *Scirpus ancistrochaetus* Schuyler. Unpub. report prepared for The Nature Conservancy and the U.S. Fish and Wildlife Service. 14 pp.
- _____. 1991. Element stewardship abstract for *Scirpus ancistrochaetus*. Unpub. abstract prepared by the Eastern Heritage Task Force, The Nature Conservancy. 12 pp.
- U.S. Fish and Wildlife Service. 1990. Endangered and threatened wildlife and plants; proposed endangered status for *Scirpus ancistrochaetus* (northeastern bulrush). *Federal Register* 55: 46963-46968.
- _____. 1991. Endangered and threatened wildlife and plants; determination of endangered status for *Scirpus ancistrochaetus* (northeastern bulrush). *Federal Register* 56: 21091-21096.

PART III: IMPLEMENTATION

The Implementation Schedule that follows lists and ranks tasks that should be undertaken within the next three years in order to implement the recovery program for *Scirpus ancistrochaetus*. This schedule will be reviewed annually until the recovery objective is met, and priorities and tasks are subject to revision. The tasks are arranged in priority order, based on the following criteria:

Priority 1

An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2

An action that must be taken to prevent a significant decline in the species population/habitat quality, or some other significant negative impact short of extinction.

Priority 3

All other actions necessary to meet the recovery objectives and provide for full recovery of the species.

Agencies and organizations with recovery responsibilities are designated in the Implementation Schedule according to the following key:

FWS	=	U.S. Fish and Wildlife Service
R5	=	Region Five, U.S. Fish and Wildlife Service
COE	=	U.S. Army Corps of Engineers
FS	=	U.S. Forest Service
PO	=	Private organizations and research institutions
SCA	=	State Conservation Agencies:
		Maryland--Natural Heritage Program (Department of Natural Resources)
		Massachusetts--Natural Heritage and Endangered Species Program (Division of Fisheries and Wildlife)

New Hampshire--Natural Heritage Inventory (Department of Resources and Economic Development)

New York--Natural Heritage Program (Department of Environmental Conservation)

Pennsylvania--Natural Diversity Inventory (Department of Environmental Resources, The Natural Conservancy, Western Pennsylvania Conservancy)

Vermont--Natural Heritage Program (Agency of Natural Resources)

Virginia--Division of Natural Heritage (Department of Conservation and Recreation)

West Virginia--Natural Heritage Program (Department of Commerce, Labor, and Environmental Resources)

TNC = The Nature Conservancy

IMPLEMENTATION SCHEDULE

NORTHEASTERN BULRUSH (*Scirpus ancistrochaetus*) RECOVERY PLAN

July 1993

PRIORITY	TASK DESCRIPTION	TASK NUMBER	DURATION	RESPONSIBLE AGENCY		COST ESTIMATES \$000			COMMENTS
				US FWS	OTHER*	FY1	FY2	FY3	
1	Identify essential <i>S. ancistrochaetus</i> habitat.	1.1	2 years	R5	SCA, FS	1	1		Habitat protection tasks will continue with discovery of new populations.
1	Identify, monitor, and alleviate threats to each population.	1.2	ongoing	R5	SCA, TNC	10	10	8	+ 2000/yr for FY4-10.
1	Secure permanent protection for known populations.	1.3	10	R5	FS, TNC, SCA	20	30	30	Roughly \$200,000 total costs estimated for land acquisition, with initial expenditures for high priority sites.
1	Coordinate with COE to ensure that permits issued do not adversely affect extant populations.	1.51	ongoing	R5	COE, SCA				No costs itemized for this task.
1	Coordinate with state agencies and Natural Heritage programs to ensure full protection under applicable state laws.	1.52	ongoing	R5	SCA				No costs itemized for this task.
2	Seek cooperation and support of private landowners and public land managers to protect occupied habitat.	1.4	ongoing	R5	SCA, TNC				No costs itemized for this task.
2	Resurvey sites thought to have suitable habitat.	2.1	3 years	R5	SCA, FS	8	6	6	
2	Identify potentially suitable habitat for additional surveys.	2.2	1-2 years	R5	SCA, FS	3	2	2	

Northeastern Bulrush Implementation Schedule, July 1993

PRIORITY	TASK DESCRIPTION	TASK NUMBER	DURATION	RESPONSIBLE AGENCY		COST ESTIMATES \$000			COMMENTS
				US FWS	OTHER*	FY1	FY2	FY3	
2	Survey potential sites for the presence of <i>S. ancistrochaetus</i> .	2.3	3 years	R5	SCA, FS	5	5	5	+ \$5000 in FY5.
2	Intensively monitor five study sites for demographic data and trends.	4.1	ongoing	R5	SCA, PO	6	5	5	+ \$5000/yr for FY4-10.
2	Monitor 20 other representative populations for general population and habitat information.	4.2	ongoing	R5	SCA	8	8	8	+ \$8000/yr for FY4-10.
2	Determine how environmental and habitat conditions affect sexual reproduction and recruitment.	5.22	4-6 years	R5	SCA, PO	4	3	3	+ \$2000/yr for FY4-6. Long time frame necessary due to highly variable hydrological regime from year to year.
2	Determine how environmental and habitat conditions affect vegetative reproduction and recruitment.	5.24	4-6 years	R5	SCA, PO	4	3	3	+ \$2000/yr for FY4-6.
2	Investigate the effects of land management practices on the bulrush.	6.3	10 years	R5	SCA	1	1	1	+ \$1000/yr for FY4-6.
2	Securely store seeds from each genotype.	8.1	ongoing	R5	PO	0.5	0.5	0.5	+ \$500/yr for FY4-10. Storage is an ongoing event.
2	To safeguard the smallest populations, cultivate shoots or seeds and maintain in a secure environment.	8.2	ongoing	R5	PO	0.5	0.5	0.5	+ \$500/yr for FY4-10. Maintenance is an ongoing event.
2	Evaluate the genetic identity of individual plants.	7.1	2 years	R5	PO	2.5	2.5		
2	Determine the degree of intra- and inter-population genetic variability.	7.2	2 years	R5	PO		5	7.5	
2	Determine to what extent seed viability varies with clonality.	7.3	2 years	R5	PO			1.5	+ \$1500 in FY4.

Northeastern Bulrush Implementation Schedule, July 1993

PRIORITY	TASK DESCRIPTION	TASK NUMBER	DURATION	RESPONSIBLE AGENCY		COST ESTIMATES \$000			COMMENTS
				US FWS	OTHER*	FY1	FY2	FY3	
3	Verify, monitor, and protect any additional <i>S. ancistrochaetus</i> populations.	2.4	ongoing	R5	SCA, FS	0.5	0.5	0.5	+ \$500/yr for FY4-10.
3	Develop consistency in the definition of plant terms with respect to <i>S. ancistrochaetus</i> .	3.1	1 year	R5	SCA, PO			0.5	
3	Develop methods to identify non-sexually reproducing individuals readily in the field.	3.2	1 year	R5	SCA, PO	4			
3	Describe methods for measuring the size and health of individual plants.	3.3	1 year	R5	SCA, PO	0.5	0.5	0.5	
3	Develop techniques and methods for quantitative monitoring of five study populations.	3.41	1 year	R5	SCA, PO	2			
3	Develop techniques and methods for monitoring other representative sites.	3.42	1 year	R5	SCA, PO	1			
3	Determine and assess demographic characteristics of five study populations.	5.1	6-8 years	R5	SCA, PO		2.5	2.5	+ \$2500/yr for FY4-9.
3	Determine the success and frequency of sexual reproduction/recruitment.	5.21	4-6 years	R5	SCA, PO		1	1	+ \$1000/yr for FY4-7.
3	Determine the success and frequency of asexual reproduction/recruitment.	5.23	4-6 years	R5	SCA, PO		1	1	+ \$1000/yr for FY4-7.
3	Under controlled conditions, determine requirements for seed germination and nodal shoot establishment.	5.31	2 years	R5	SCA, PO		3	3	

Northeastern Bulrush Implementation Schedule, July 1993

PRIORITY	TASK DESCRIPTION	TASK NUMBER	DURATION	RESPONSIBLE AGENCY		COST ESTIMATES \$000			COMMENTS
				US FWS	OTHER*	FY1	FY2	FY3	
3	Experimentally determine the habitat specificity and recruitment success of <i>S. ancistrochaetus</i> .	5.32	5 years	R5	SCA, PO			3	+ \$3000/yr for FY4-7.
3	Investigate the significance of seed banking and seed dispersal.	5.4	3-4 years	R5	SCA, PO			1	+ \$1000/yr for FY4-6.
3	Characterize the habitat of the five study sites.	6.1	3 years	R5	SCA		5	5	+ \$2500 in FY4. At least 3 years needed to characterize hydrological regime.
3	Identify competitors and determine to what degree and under what conditions they may threaten <i>S. ancistrochaetus</i> .	6.2	3 years	R5	SCA		1	0.5	+ \$500 in FY4.
3	Investigate the effects of beaver activities on the hydrological regime and demography of the bulrush.	6.4	8 years	R5	SCA		0.5	0.5	+ \$500 for FY4-9.
3	Develop an information brochure/packet.	10	1 year	R5	SCA		3		+ \$2000 (reprint).

APPENDIX

Current Laws and Regulations Protecting the Northeastern Bulrush

FEDERAL LAWS AND REGULATIONS

Endangered Species Act. Section 7(a)(2) the Endangered Species Act of 1973, as amended, requires Federal agencies, through consultation with the U.S. Fish and Wildlife Service, to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of species listed as endangered or threatened. Section 9 of the Act, as amended, prohibits the removal and reduction to possession or the malicious damage to or destruction of endangered or threatened plants from areas under Federal jurisdiction. This section also prohibits the removal, cutting, digging, damaging, or destruction of these species on other areas in knowing violation of state regulations or laws or in the course of violating state criminal trespass laws.

Wetlands regulations. Wetlands of the type that may support northeastern bulrush populations would typically fall into the category of "headwaters and isolated waters" (Nationwide Permit 26) under Federal wetland regulations (56 CFR 59134-59147, Part 330-Nationwide Permit Program) administered by the U.S. Army Corps of Engineers. A nationwide permit (NWP) is a general permit issued on a nationwide basis to authorize activities with little or no paperwork. NWP 26 allows the permittee to discharge dredged or fill material into headwaters and isolated waters provided "the discharge does not cause the loss of more than 10 acres of waters," and provided the permittee notifies the district engineer if the discharge would cause the loss of greater than one acre in accordance with the "Notification" general condition. It should be noted, however, that "no activity is authorized under any NWP which is likely to jeopardize the continued existence of a threatened or endangered species . . . as identified under the Federal Endangered Species Act . . ." (56 CFR 59145, emphasis added). Further, "non-federal permittees shall notify the district engineer if any listed species or critical habitat might be affected or is in the vicinity of the project and shall not begin work on the activity until notified by the district engineer that the requirements of the Endangered Species Act have been satisfied and that the activity is authorized. Information on the location of threatened and endangered species and their critical habitat can be obtained from the U.S. Fish and Wildlife Service" (56 CFR 59145, emphasis added). In effect, wetland habitats occupied by endangered species, including the northeastern bulrush are not covered under any NWP, including NWP 26.

In addition, a state Section 401 Water Quality Certificate (WQC) or waiver is required for the nationwide permits (such as NWP 26) that may result in a discharge of dredged or fill material. In accordance with Corps regulations (33 CFR 330.4(c)), a State may issue, waive or deny the blanket certification for an NWP authorization. If a state denies this authorization, an activity-specific 401 certification must then be obtained from the state before any activity which would otherwise comply the NWP authorization can proceed. Currently, all states within the range of *S. ancistrochaetus* have denied 401 Water Quality Certification for NWP 26, as well as several other NWPs. As a result, most of

these states now review individual NWP's, and part of this review process often involves a state review of the project area for species of special concern (Federal or state endangered, threatened, or rare). During these reviews, states have the opportunity to protect known wetland habitats of endangered and threatened species.

STATE LAWS AND REGULATIONS

MARYLAND

The northeastern bulrush is listed as an endangered species under Maryland's endangered species regulations (COMAR 08.03.08). The state regulates trade and commerce of listed species. Activities involving state funding and permitting are also regulated to allow for the protection of endangered species. In addition, taking of listed plants from private property is prohibited without written permission of the landowner (U.S. Fish and Wildlife Service 1991; R. Bartgis, Maryland Natural Heritage Program, pers. comm.).

Additional protection may be gained through Maryland's nontidal wetland regulations (COMAR 08.05.04), which "can prohibit all development activities in wetlands and an adjacent 100-foot buffer if the wetlands support endangered species. However, this provision applies to specific designated wetlands" which currently does not include the northeastern bulrush site (R. Bartgis pers. comm.).

MASSACHUSETTS

Since January 1992, the northeastern bulrush has been listed as endangered under the Massachusetts Endangered Species Act (Massachusetts General Law Chapter 131A). Under this law, it is illegal for any person, including the landowner, to take endangered or threatened species without a permit. "Take" is defined as collect, pick, kill, transplant, cut, or process, or attempt to engage or assist in any such activity. Under the regulations, permits for take of endangered species may be issued by the Division of Fisheries and Wildlife for educational and scientific purposes, and for captive propagation (H. Woolsey, Massachusetts Natural Heritage Program, pers. comm.).

The northeastern bulrush receives limited protection under the Massachusetts Wetland Protection Act (Chapter 131, Section 40), and the corresponding regulations (310.00 CMR, Section 40), which regulate activities in "isolated lands subject to flooding," the category of wetland likely to fit those wetlands occupied by the northeastern bulrush (H. Woolsey pers. comm.). Additional regulations that address the protection of wetlands harboring endangered and threatened species are certainly warranted.

NEW HAMPSHIRE

In New Hampshire, the northeastern bulrush is legally protected under the New Hampshire Native Plant Protection Act (RSA 217-A). This law prohibits the take of endangered and threatened plants on state and private property without a permit; landowners, however, are exempt from the permit requirements. Currently, the law also requires that anyone applying for a wetland, subdivision, or "significant alteration of

terrain" (disturbance of $>100,000 \text{ ft}^2$) permit must consult with the New Hampshire Natural Heritage Program to determine whether or not any state-listed species may be impacted by project activities (A. Cutko, New Hampshire Natural Heritage Program, pers. comm.). Unfortunately, this provision will likely be deleted from the law effective July 1, 1993, eliminating a great deal of protection for the northeastern bulrush site in New Hampshire.

PENNSYLVANIA

In Pennsylvania, the northeastern bulrush is legally classified as a state endangered species, and thereby receives protection under the Wild Resources Conservation Act (25 PA Code, Chapter 82). Under these regulations, a permit is required to collect, remove, or transplant wild plants classified as endangered or threatened; landowners, however, are exempt from the permit requirements. The same regulations also provide for the establishment of native wild plant sanctuaries on private lands where there is a management agreement between the landowner and the State Department of Environmental Resources. Habitat of the northeastern bulrush receives protection under regulations of the Dam Safety and Encroachments Act (25 PA Code, Chapter 105). Wetlands which serve as habitat for state or Federally listed endangered or threatened species and "wetlands that are hydrological connected to or located within 1/2-mile of wetlands identified" as endangered or threatened species habitat and "that maintain the habitat of the threatened or endangered species within the wetland" are categorized as "exceptional value wetlands" (section 105.17). "The Department will not grant a permit under this chapter for a dam, water obstruction or encroachment located in, along, across or projecting into an exceptional value wetland, or otherwise affecting an exceptional value wetland," unless (among other things) it will not have an adverse impact on the wetland.

VERMONT

The northeastern bulrush is listed as an endangered species under the Vermont Endangered Species Law (10 V.S.A. chapter 123). The law prohibits taking, possession, or transport by any person, unless exempted, or authorized by certificate of permit. Permits may be granted for scientific purposes, enhancement of survival of the species, economic hardship, educational purposes or special purposes consistent with the purposes of the Federal Endangered Species Act (U.S. Fish and Wildlife Service 1991). The law, however, has silvicultural and agricultural exclusions and does not protect habitat of endangered species (R. Popp, Vermont Natural Heritage Program, pers. comm.).

Under Vermont's wetlands regulations, 10 V.S.A. Chapter 37, Section 905(a)(7-9), the habitat occupied by the two northeastern bulrush populations would be classified and protected as "Class II wetlands" because these wetlands appear, or are connected to wetlands that appear, on National Wetlands Inventory maps. Any attempt to fill or drain these wetlands would require a "conditional use determination" which would, presumably, be denied by the Department of Environmental Conservation because of the presence of the bulrush (R. Popp pers. comm.).

VIRGINIA

The northeastern bulrush is listed as an endangered species in Virginia, and is thereby protected under the Endangered Plant and Insect Species Act of Virginia (1979,

c.372). This law, and the corresponding regulations, prohibit the taking of endangered species without a permit; however, landowners are exempt from the permit requirements. The Department of Agriculture and Consumer Services also regulates the sale and movement of listed plants and establishes programs for the management of listed plants (U.S. Fish and Wildlife Service 1991).

Habitat of the northeastern bulrush may receive protection under the State Water Control Law and the corresponding regulations pertaining to Water Quality Standards (VR680-21-07.2), which are administered by the State Water Control Board. Under the regulations, wetland habitats supporting listed species are classified as "waters containing endangered or threatened species," a subcategory under "outstanding state resource waters," which are subject to protections found in the anti-degradation policy. At this time, wetland habitats supporting northeastern bulrush populations are not specifically listed or designated in the regulations; however, "If the U.S. Fish and Wildlife Service identifies new waters containing endangered or threatened species, the Board shall consider the need to protect these beneficial uses in reviewing discharge permits and other actions until such time as the waters are officially added to the list in this section" (VR680-21-07.2, C).

WEST VIRGINIA

There is currently no state endangered species legislation in West Virginia, however, habitat of the northeastern bulrush may receive some degree of protection under the state wetland regulations (Title 47, Chapter 20, Series 5A Regulations for State Certification of Activities requiring Federal Licenses or Permits). In West Virginia, the Department of Natural Resources reviews all wetland permits. A review for the presence of known occurrences of Federally listed species is part of this process, which may help ensure the protection of those sites occupied by the northeastern bulrush.

LIST OF REVIEWERS

The following individuals and agency representatives provided comments to the Service on the Northeastern Bulrush (*Scirpus acistrochaetus*) Draft Recovery Plan. Their comments, copies of which are on file in the Pennsylvania Field Office of the U.S. Fish and Wildlife Service, were incorporated as appropriate into the final plan.

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Addendum

Identification of Vegetative Plants of Scirpus ancistrochaetus Schuyler

Alfred E. Schuyler

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Scirpus ancistrochaetus, along with many other sedge species, produces two kinds of above-ground shoots: caulescent and foliose. Caulescent shoots have leafy stems (culms) that protrude above the substrate and bear terminal inflorescences. Occasionally caulescent shoots may lack inflorescences when their growing tips are damaged by herbivores, adverse environmental conditions, etc. Foliose shoots have dense clusters of leaves from stems that remain in the substrate or barely protrude above it. Since growth is only vegetative in foliose shoots, they also can be regarded as vegetative plants although an individual plant may consist of one or more foliose shoots connected by underground rhizomes.

Depending on the species and the environmental conditions, one of the two kinds of shoots may dominate a given site. For example, Scirpus longii Fern usually occurs in stands dominated by foliose shoots except after disturbances such as fire (Schuyler & Stasz 1985). This study was initiated to determine if stands of S. ancistrochaetus are overlooked because they occur as foliose shoots or vegetative plants that lack reproductive structures ordinarily used for identification.

Methods

Eight sites for S. ancistrochaetus in the states of New Hampshire (two sites), Vermont (two sites), Massachusetts (one site), and Pennsylvania (three sites) were visited during August 1993 (Table 1). Five of the sites were ponds that had water regimes manipulated by beavers, two were sink-hole ponds, and one was a glacial depression lacking an outlet stream. At each site the relative abundance of caulescent and foliose shoots was evaluated with respect to hydrological gradients. Other sedges present at the sites were recorded and their foliose shoots were compared with those of S. ancistrochaetus. Foliose shoots of two closely related species, S. atrovirens Willd. and S. hattorianus Mak., were examined from nearby sites for comparison purposes.

Results

Plants of S. ancistrochaetus were found along a hydrological gradient ranging from exposed moist substrates to substrates inundated to 75 cm. When water depths exceeded 15 cm, only foliose shoots were present. In shallower water, on floating mats of vegetation, or on moist substrates, both foliose and caulescent shoots were present. Hydrological conditions varied enough at each site for identifiable caulescent shoots to occur at all of them. Thus it was possible to recognize all of the foliose shoots of S. ancistrochaetus by carefully comparing foliose with caulescent shoots. In wetter portions of the sites, where caulescent shoots were not present, foliose shoots of S. ancistrochaetus were readily distinguishable from those of other species intermixed with them.

Scirpus atrovirens and S. hattorianus have foliose shoots that are difficult to distinguish from S. ancistrochaetus, but are unlikely to be confused with it because of habitat differences. Apparently they cannot tolerate the wetter conditions associated with fluctuating water regimes. In situations where these species grow in close proximity to S. ancistrochaetus, they can be distinguished by characteristics of inflorescence-bearing caulescent shoots (Schuyler 1967). Neither foliose nor caulescent shoots of these species were found intermixed in this study.

Two other species of Scirpus, S. cyperinus (L.) Kunth and S. microcarpus Presl (S. robrotinctus Fern.) were found intermixed with S. ancistrochaetus, but were readily distinguishable by characteristics of their foliose shoots. Scirpus cyperinus has more narrowly elongate and more rigid leaves that are V-shaped in cross-section. The broader, shorter, and less rigid leaves of S. ancistrochaetus have downward longitudinal folds between their midribs and margins, and thus are more like a pair of wings in cross-section. Foliose shoots of S. microcarpus, which are very similar to those of S. ancistrochaetus, have a reddish-brown pigment near the base of their leaf sheaths. This pigment is absent in leaf sheaths of S. ancistrochaetus.

Foliose shoots of most species of Carex growing with S. ancistrochaetus, e.g., Carex gynandra Schwein., C. lupulina Muhl, ex Willd., C. lurida Wahlenb., C. scoparia Schkuhr ex Willd., and C. vesicaria L., are obviously angled near the base at ground level while they are obscurely so in S. ancistrochaetus. Carex utriculata Boott (Carex rostrata Stokes sensu lato) and Scirpus ancistrochaetus, which occasionally grow intermixed in shallow water, have similar foliose shoots that are obscurely angled at the base. Carex utriculata differs, however, by having upward-protruding prickly hairs on the upper leaf surfaces that make them feel like fine sandpaper in contrast to the smooth upper leaf surfaces of S. ancistrochaetus. Leaves of C. utriculata also have much finer tapering tips.

Conclusions

It is unlikely for vegetative plants of Scirpus ancistrochaetus to be overlooked by careful searchers. Foliose shoots can be recognized by comparing them to the more readily identifiable caulescent shoots that are present at most sites. Foliose shoots of Scirpus atrovirens and S. hattorianus, the species most closely resembling S. ancistrochaetus, do not pose a problem because they rarely, if ever, grow intermixed with S. ancistrochaetus. Foliose shoots of other species of Scirpus and several species of Carex that grow intermixed with foliose shoots of S. ancistrochaetus differ substantially enough to not be confused with it.

Acknowledgments

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References

- Schuyler, A.E. 1967. A Taxonomic Revision of North American Leafy Species of Scirpus.
Proceedings of the Academy of Natural Sciences of Philadelphia 119: 295-323.
- Schuyler, A.E. and J.L. Stasz. 1985. Influence of Fire on Reproduction of Scirpus longii.
Bartonia 51:105-107.

Table 1. Sites for Scirpus ancistrochaetus visited in 1993

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1. New Hampshire: Sullivan County: about 3.3 kilometers south southeast of Charlestown, beaver pond.
 2. New Hampshire: Sullivan County: about 2.8 kilometers northeast of North Walpole, two beaver ponds (North Pond and small pond between North and Middle ponds).
 3. Vermont: Windham County: about 3.6 kilometers northeast of Rockingham, Bulrush Meadows, pond on Connecticut River floodplain flooded by beavers.
 4. Vermont: Windham County: about 4 kilometers north northwest of Townshend, Joy Basin, three beaver ponds.
 5. Massachusetts: Franklin County: about 4.7 kilometers north northeast of Montague, glacial depression.
 6. Pennsylvania: Clinton County: about 3.7 kilometers northeast of Rosecrans, Rosecrans Bog, depression flooded by beavers.
 7. Pennsylvania: Cumberland County: about 1.9 kilometers southeast of Cleversburg, Thomas Hollow Pond, depression near base of South Mountain.
 8. Pennsylvania: Franklin County: about 3.8 kilometers east southeast of Scotland, Mountain Run Ponds (number one), depression near base of South Mountain.
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